Nordic Water 2012

XXVII NORDIC HYDROLOGICAL CONFERENCE

ABSTRACTS

Catchment Restoration and Water Protection

Editors
RIITTA KAMULA BJØRN KLØVE HANNA AROLA

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Preface

Nordic Water is a conference series focusing on water resources, hydrology and related sciences. Providing good solutions to our water resources requires an interdisciplinary approach. The aim of the conference is to bring together scientists, managers and decision makers to talk about recent trends in water research and water resources management.

In Europe, an important issue is the EU Water Framework Directive and the Groundwater Directive that strive for good water quality for human and ecosystem needs. Finding cost-efficient and acceptable methods to improve the status of water bodies is an essential task for the future. Northern conditions set special requirements regarding the natural environment, climate and socio-economic development. Generally, water is highly valued and good water quality is required both for our potable water, watercourses and groundwater systems. This calls for high level research and knowledge.

Nordic Water 2012 conference will present recent scientific progress from many fields of hydrology and water resources. In total over 200 abstracts were submitted from almost 40 countries in all the continents except the Antarctic. Most of the contributions came from the Nordic and Baltic countries. These contributions have been set to over ten scientific sessions covering also the conference main theme on catchment restoration and water protection. All submitted abstracts were evaluated by our scientific committee. After the conference authors are given a possibility to submit their original contributions for publication in a special issue of Hydrology Research.

We thank all the contributors who have made this conference possible. This includes our scientific committee and all persons in the organizing committee. We also thank all the authors who submitted either oral or poster presentations. Especially we would like to thank the five keynote speakers Cintia Bertacchi Uvo, John Doherty, Nikolai Friberg, Aaron Packman, and Per Stålnacke. The funding from all the sponsors is well acknowledged. Special thanks are to our main sponsors Finnish Ministry of Forestry and Agriculture, Federation of Finnish Learning Societies, Maa - ja vesitekniikan tuki r.y., Maj and Tor Nessling foundation, Sven Hallin Foundation, and University of Oulu.

Bjørn Kløve

Chair of scientific committee
University of Oulu, Department of Process and Environmental Engineering, Water Resources and Environmental Engineering

Riitta Kamula

Chair of organizing committee
University of Oulu, Thule Institute

Introduction of Keynote Speakers

John Doherty (Australia)

"Environmental modeling - encapsulating what we known and quantifying what we don't"

Dr. John Doherty works primarily as a private consultant. He also works in a part-time capacity at the National Centre for Groundwater Research and Training at Flinders University, Australia. There is a considerable overlap between his research and consulting interests. These focus mainly on the following topics, all of which attempt to serve the greater purpose of maximising the use of environmental modelling in the decision-making context:

- Solution of the inverse problem of model calibration in ways that are numerically efficient but that allow maximum usage of both field data and expert knowledge
- Quantification of the uncertainty associated with model predictions of management interest
- Development of a theoretical understanding of the benefits and costs of simplicity vs. complexity in environmental models
- Appropriate use of models in the environmental decision-making process.

Per Gustav Stålnacke (Norway)

"How slow can it be? Spatial and temporal considerations on nutrient retention from source to river mouth"

Dr. Per Stålnacke is the head of the Department of Water Quality and Hydrology at Bioforsk Soil and Environment, Norway, and is also vice-President of IAHS ICWQ. His research interests lie in integrated water resources management and the policy-science interface. In addition, he has considerable experience in assessment of nutrient fluxes at river basin scale. According to Dr. Stålnacke, there is a huge research need to accurately quantify hydrological pathways and develop better tools to assess and improve the understanding of how long it may take before we can observe improved water quality due to mitigation measures implemented. These are the apparent needs in relation to the WFD and the HELCOM BSAP. At Nordic Water 2012, Dr. Stålnacke will present and discuss some very recent results on nutrient retention in the Baltic Sea drainage area and time trends in selected rivers in the Baltic Sea countries and Europe.

Cintia Bertacchi Uvo (Sweden)

"The interacting system of climate and hydrology"

Cintia Bertacchi Uvo is a Professor at the Department of Water Resources Engineering, Lund University. Her research interests lie on how climate and hydrology affect, interact and relate to each other in different time and space scales, typically from monthly to decadal. Prof. Uvo's work is essentially interdisciplinary and dedicated to understanding of processes that are then statistically modelled and applied. In the latest years, the development of seasonal hydrological forecast based on climate variability has included a large part of her research. Her work is very collaborative and international. Applications of her work have been made in many parts of the world and in collaboration with diverse institutions worldwide.

Prof. Uvo is also very active in education of doctoral students and has created several international courses with the objective of stimulating young researcher to comfortably walk on the bridge that connects climate and hydrology.

Aaron Packman (USA)

"Overview of surface-groundwater interactions in the context of river degradation, water quality and ecosystem processes"

Aaron Packman is a Professor at the Department of Civil and Environmental Engineering, McCormick School of Engineering and Applied Sciences, Northwestern University. His research focuses on environmental and microbial transport processes, with particular emphasis on understanding the basic processes that control interfacial transport in aquatic systems and the coupling of physical transport processes with biological and biogeochemical processes in dynamic natural environments such as rivers. Prof. Packman's work is highly collaborative and encompasses basic fluid mechanics, particle transport and morphodynamics, microbiology, and aquatic and surface chemistry. Important applications include contaminant transport and water quality, microbial habitat conditions and benthic microbial ecology, nutrient and carbon cycling, ecosystem degradation and restoration, control of biofilm-based infections, and the transmission of waterborne disease.

Prof. Packman has received several awards for his work, including Career awards from the U.S. National Science Foundation and National Institute of Health, and the Huber Research Prize from the American Society of Civil Engineers. He is currently associate editor of the leading aquatic sciences journal Limnology and Oceanography – Fluids and Environments, and is vice-President of the International Association for Sediment Water Science. He is also very active on technical committees and panels addressing sediment contamination, hydrological synthesis and waterborne disease transmission.

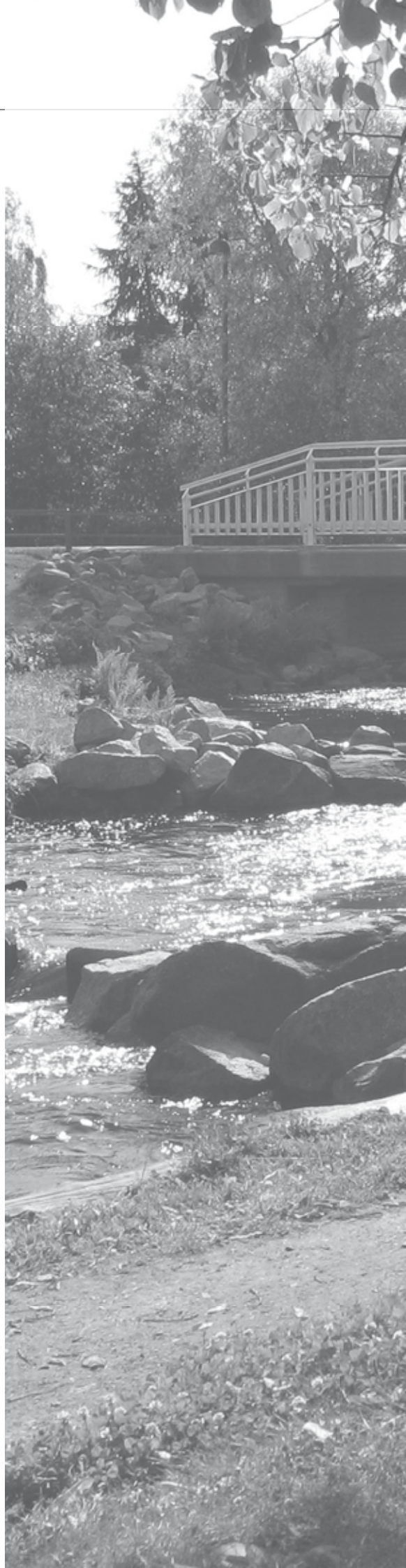
Nikolai Friberg (Denmark)

"Restoring stream ecosystems in a changing climate"

Dr. Nikolai Friberg is Deputy Head of the Department of Bioscience at Aarhus University. He has more than 20 years of research experience in the field of freshwater ecology, working both in Denmark and abroad. The main focus of his research is on applied issues and how anthropogenic disturbance affects freshwater communities. His scientific work in the past has evolved around community ecology and centred on three overall themes:

- The influence of habitats and anthropogenic stressors (organic pollution, pesticides, etc.) on stream biota and ecosystem processes
- The influence of riparian areas and catchment land use on stream communities and biological structure, including effects of restoration measures
- The effects of climate change on stream ecosystem structure and functioning, including food web architecture.

His main research interest at present relates to the interactions between organisms across levels of organisation and how this influences ecosystem processes, including recently how food webs change in relation to climate. He is currently involved as Work Package leader in a new EU FP 7 project, REFORM, on detecting habitat degradation and developing evidence-based ways of restoring rivers. He is currently President of NORBS (Nordic Benthological Society) and is the Danish representative in CHIN and Euraqua.



Abstracts

Preventive flood protection: Land use impact on the water harvest - using a modified physical based model at a catchment scale

M. Abuhashim[1], H. Lilienthal[2] and E. Schnug[2]

[1]Faculty of Agriculture, University of El-Zagazig, P.O. Box 44511, El-Sharkia, Egypt, e-mail: mabuhashim@gmx.de

[2]Julius Kühn-Institute of cultivated plants (JKI), Institute of crop and soil science, Bundesallee 50, 38116 Braunschweig, Germany, e-mail: holger.lilienthal@jki.bund.de

The extreme flood events in recent years have increased in several parts of Europe and initiated a debate on the role of the land-use and land-management changes as measures for preventive flood protection. The dynamics of soil water has been investigated to identify the impact of different land-use and land-management on the soil water storage capacity in the Schunter catchment (Niedersachsen, Germany). Based on the NRCS-Curve Number approach, a modified model (CN_m) to determine the water storage capacity on regional scale has been developed and provides a suitable tool to investigate the impact of different land-use and land-management on the infiltration properties Abuhashim et al. (2009). The impact of forest on the total water storage capacity of the catchment increases since 1950, although the absolute area of forest has not changed very much. In addition, the infiltration capacity from 1950 to 2009 for the whole catchment reveal that the amount of the potential infiltration capacity used is reduced by 17 % with reducing the infiltrating area and increasing the urbanization impact.

Increasing the urbanization activity from 1950 to 2009 by 6% and decreasing the cropland by 8%, the infiltrating area decreased from 57527 hectare in 1950 to 53480 hectare in 2009, and the contribution of the grassland and the forest to the infiltration capacity increased compared to the cropland impact Abuhashim et al. (2010). Simulations based on different land-use and land-management scenarios revealed that the water storage capacity of a catchment can be increased by 1 % with organic management compared to 0.4 % with conservation management.

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Empirical models for sediment transport from hillslopes in hydrological watersheds

Hafzullah Aksoy[1] and Ebru Eris[2]

[1]Istanbul Technical University, Department of Civil Engineering, Hydraulics Division 34469 Maslak, Istanbul, Turkey, e-mail: haksoy@itu.edu.tr
[2]Ege University, Department of Civil Engineering, Hydraulics Division Izmir, Turkey, e-mail: ebru.eris@ege.edu.tr

The dead storage volume of river reservoirs is of great importance in the design of water structures. It is such a volume that accomodates the sediment trapped by and accumulated in the reservoir. Neither underestimation nor overestimation of this volume is desired as the underestimation shortens the economical life of the reservoir and the overestimation results in unneccessary costs. Therefore, quantification of soil erosion from hillslopes in hydrological watersheds is of high importance.

Numerous methods are available to quantify that amount of sediment. In practice, this might be either by analysing a time series; correlating the collection of available data (Phien, 1981); employing empirical approaches and traditional equations (Bogardi, 1974); monitoring, sampling, surveying; or remote sensing and using geographical information systems (Baban & Yusof, 2001). Additionally, process-based hydrological watershed models (Kavvas *et al*., 2006) and wavelet type soft computational techniques (Aksoy *et al*., 2004) were found useful in establishing a model for forecasting or simulation purposes.

In this study, sediment transport over a bare soil is analyzed through a laboratory experimental setup consisting of a rainfall simulator and an erosion flume that can be given longitudinal and lateral slopes. Medium and fine sands are used as soil. Four rainfall intensities (45, 65, 85 and 105 mm/hour) are applied on the flume with combinations of lateral and longitudinal slopes of 5, 10, 15, 20%. As a microtopographical structure, a longitudinal rill with a triangular cross-section was preformed in the soil along the flume before the rainfall is applied. Eighty experiments were performed.

In each experiment, flow is measured. Sediment within flow is separated and weighed. Experimental data were analyzed to achieve empirical equations between sediment discharge, slope, flow discharge, rainfall and sediment size among which slope is found an effective variable in the sediment discharge from hillslopes with microtopography.

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Effect of climate change on recharge and water budget in Rokua esker aquifer, Finland

Pertti Ala-aho[1] and Bjørn Kløve[1]

[1]Water Resources and Environmental Engineering Laboratory, Department of Process and Environmental Engineering, University of Oulu; P.O. Box 4300, 90014 University of Oulu, Finland; e-mail: pertti.ala-aho@oulu.fi

Management of groundwater resources requires accurate estimates of groundwater recharge. The methods for estimating recharge are various and the choice of an accurate technique can be difficult. In Finland, climatic conditions impose two important factors to consider in recharge estimations; during winter most of the precipitation is accumulated as snow and soil frost changes the permeability of the soil (Okkonen, 2011). These factors are considered to change in the near future due to foreseen climate warming.

The first objective of this study is to analyze climate data in order to detect possible trends and periodic behavior in the study site historical climate. Local climate data and large scale climatic processes, characterized by teleconnection indices, are compared to outline factors contributing to climatic variability. Secondly, groundwater recharge at the study site is simulated with CoupModel (Jansson and Karlberg, 2004), which takes into account factors peculiar to Nordic conditions. A novel aspect in the model structure is to include lichen, a plant potentially affecting soil evaporation, as a part of the soil profile. Laboratory experiments were performed to estimate water retention properties of lichen. The established model is used to simulate effects of climate change at the study site. Finally, in order to establish the water budget for the aquifer, groundwater discharge to peatlands surrounding the esker aquifer was estimated by separation of stream bases flow from the steam hydrographs. A conceptual model was then constructed to calculate the most important factors in the aquifer water budget.

Analysis of historical climate data shows an increasing trend in precipitation and statistically significant correlation of climate variables and teleconnection indices. Results of groundwater recharge simulations and water budget calculations will be elaborated. This study will add to knowledge of suitable recharge estimation methods for esker aquifers and outlines possible effects of climate change to esker aquifer hydrology in the Nordic conditions.

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Factors affecting the long-term performance of permeable concrete grid pavements

Ahmed Mohammed Al-Rubaei, Maria Viklander and Godecke-Tobias Blecken

Urban Water
Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology, 971 87 Luleå, Sweden, e-mail: ahmed@ltu.se

Introduction

Urban stormwater is of utmost importance due to high peak flows and large volumes as well as contaminanation with e.g. sediments, nutrients, heavy metals and hydrocarbons. This may cause flooding and high flows in the receiving waters and furthermore, discharge of pollutants. Thus, the most effective method for reducing urban stormwater pollution and its detrimental impacts on receiving waters is to minimize impermeable surfaces by using concepts like water sensitive urban design (WSUD) and low impact development (LID). One technology within these concepts is permeable pavements, e.g. concrete grid pavers. By enabling *in situ* infiltration, they have the ability to efficiently control runoff volumes and flows, reduce or avoid downstream flooding, recharge natural groundwater, and remove pollutants.

However, despite their benefits, implementation of permeable pavements usage is often obstructed due to concerns regarding their effective life-span (clogging), winter performance, and/or maintenance needs.

Objective

Thus, we investigate the long-term performance of a range (n>15) of permeable concrete grid pavements of different ages and different constructions in Växjö municipality, Sweden. Furthermore, we evaluate the potential of vacuum cleaning to retrieve the infiltration capacity of these pavements if clogging had occurred.

Method

We investigate the infiltration capacity of these pavements using double ring infiltrometers. This allows measuring the infiltration capacity in situ without the need to collect representative samples. Also, a general linear model is used to identify significant factors influence in infiltration capacity (age, vegetation, pavement type, maintenance).

Expected Result

Currently, measurements are ongoing. They will be completed in May 2012.
Preliminary results show that

- Concrete grid pavements tend to clog if maintenance is insufficient,
- Vegetation enhances infiltration by creating pores due to root development,
- Maintenance is crucial to avoid/minimize clogging,
- Pre-treatment (sedimentation is beneficial).

Changes in hydrological regime of the lakes in Latvia

Elga Apsīte[1], Andrejs Zubaničs[1], Didzis Elfers[1, 2] and Inese Latkovska[1, 3]

[1]University of Latvia, Faculty of Geography and Earth Sciences, Raiņa bulv. 19, Rīga LV-1586, Latvia, e-mail: elga.apsite@lu.lv
[2]University of Latvia, Faculty of Biology, Kronvalda bulv. 4, Rīga, LV-1586, Latvia
[3] Latvian Environment, Geology and Meteorology Centre, Maskavas 165, Riga LV-1019, Latvia

Lakes are one of the most common landscape elements in Latvia and in the Baltic range which stretches with some highlands of lakes in Lithuania, Poland and Northern Germany. The dynamics of the condition of the lakes over the time is best characterised by the regime of the water level and its changes which are subject to impact of a set of different natural and anthropogenic factors. These rhythmic fluctuations are caused by different macro processes, like the atmospheric circulation, changes in the solar radiation which determine the thermal and ice regime of the lakes, as well as the amount of precipitation.

Broader research on the hydrological regime of the Latvian lakes and its changes were carried out in the 1930-ies and in the 1950-ies to 1970-ies on the morphometry, the thermal and ice, e.g. Stakle (1935) and Glazačeva (Глазачева, 1965). The publication L.Glazačeva (2004) is one of the last summary issues about the hydrological regime of the Latvian lakes and its changes. It should be noted that lately no broader research on this topic have been carried out, and generally as from year 2003-2004 regular monitoring of the Latvian lakes is no longer performed.

This study summarises the results of the research on the long-term and seasonal changes in the water level, thermal and ice regimes in seven biggest lakes of Latvia and their regional peculiarities from year 1926 to 2002. The water level of the lakes Usma, Ludzas, Sventes and Rāzna has been controlled, however as regards the lakes Burtnieks and Liepājas it can be deemed that the changes of the water level have taken place due to the impact of natural factors during the research period. The global climate warming has caused considerable changes in the hydrological regime of the lakes during last decades when the water level and the water temperature have increased and the number of days with ice cover and the thickness of ice have decreased. A positive trend in the freezing data and statistically reliable negative trend for the ice break-up date have been found for all the lakes. The lakes Liepājas and Usma is located in the Western part, therefore their hydrological regimes, in particular, the thermal and ice regime, differs from the other lakes which are located in the North and East part of Latvia.

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Hydrological statistics calculated from the regional model S-HYPE

Sara-Sofia Asp, Marie Bergstrand and Göran Lindström

Swedish Meteorological and Hydrological Institute, S-601 76 Norrköping, Sweden,
e-mail: sara-sofia.asp@smhi.se, marie.bergstrand@smhi.se, goran.lindstrom@smhi.se

The aim with this project is to calculate the below mentioned statistical parameters for the discharge for the whole of Sweden. Runoff has been calculated with the hydrological model S-HYPE (Lindström et al. 2010 and Strömqvist et al. 2012), developed by SMHI. The model includes 37786 catchment areas and was run for the period 1961-2010. The following statistical parameters were calculated from daily runoff modelled by S-HYPE for all catchment areas:

- mean discharge (MQ)
- mean annual high (MHQ)
- return period of 2 years (HQ2)
- return period of 10 years (HQ10)
- return period of 50 years (HQ50)

The mean annual high (MHQ) is calculated as the average of every year's highest daily flow. The period used for calculating MQ and MHQ is 1961-2010.

The frequency analysis of HQ2, HQ10 and HQ50 is based on each year's maximum value. The Extreme Value Type I Distribution (Gumbel) with the method of moments is used. The magnitude of a hydrological event (x_T) for a return period is calculated by using frequency factors (K_T).

$$x_T = \bar{x} + K_T s \qquad \text{(equation 1)}$$

$$K_T = -\frac{\sqrt{6}}{\pi}\{0{,}5772 + LN[LN\left(\frac{T}{T-1}\right)]\} \qquad \text{(equation 2)}$$

The results will be analysed and also compared to other already existing statistical parameters (valid for some 3000 points and for the 20th century). The S-HYPE is still under development so coming versions will be used along this work.

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Sea and coastal ice phenology in Latvia

Zanita Avotniece, Lita Lizuma, Elga Apsite, Maris Klavins and Valery Rodinov

University of Latvia, Faculty of Geography and Earth Sciences, Raina blv. 19, LV- 1586, Riga, Latvia, e-mail: maris.klavins@lu.lv

Latvia as well as all the other Baltic states are subjected to climate change, which is believed to strengthen even more in the nearest future. The most vulnerable territories in Latvia, that are subjected to natural disasters of sea water level rise, storm surges and flooding, coastal erosion, also extremely high and low temperatures, are the ones situated in the coastal areas of the Baltic Sea and the Gulf of Riga.

Ice regime is sum of processes with a high sensitivity in respect to climate change and climatic variability. Within this study ice regime in waters of Riga Gulf and Baltic Sea coastal line of Latvia has been studied for a period 1924 – 2010.. According to genesis 47% of total coastline is low accumulation type and 33 % are up to 5 m high coasts with different origin - dunes, moraine clay, Devonian sandstone and clay bluffs. The total length of seacoast is 498 km and be regarded as vulnerable to above mentioned extreme events. The Potsdam Institute for Climate Impact Research has calculated that Latvia coastline can expect economical losses 1 576,414 million USD. However implementing the appropriate adaptation measures losses can be reduced by 40% (ASTRA project).

The trend analysis (Mannn-Kendal test) of ice regime reveals evident impacts of climate change processes, but at the same time evident are impacts of natural climatic variability. Climate change process affects length of ice cover, spatial coverage especially of Riga Gulf, as well as start of appearance and disappearance of ice cover. Evident and expected are differences of ice regime differences in Riga Gulf and open Baltic Sea, but they were compared also with ice regime on inland waters of Latvia. Further the relations with air temperature and amount of atmospheric precipitations were studied. As factor most directly correlated with the ice regime describing parameters water temperature can be identified. The overall warming has caused changes in the processes of the sea ice formation and persistence.

In general the stations on cost of the Baltic Sea reported earlier start of sea ice formation in autumn and earlier disappearance in spring while for Gulf of Riga the latest sea ice formation and earlier disappearance were found. Annual mean and maximum sea level were gradually rising over the observation form the end of 19^{th} century .

Another major factor affecting sea and coastal ice phenology includes large-scale atmospheric circulation processes. Within this study dominant types of atmospheric circulation patterns were determined and their impact of ice phenology were discussed.

This study is financed by Baltic Sea Region Programme (2007-2013) project Baltadapt.

Solution of a pumping cost minimization problem for the Tahtali watershed (Izmir-Turkey) using linked simulation-optimization models

M. Tamer Ayvaz[1] and Alper Elçi[2]

[1]Department of Civil Engineering, Pamukkale University, TR-20070 Denizli, Turkey, e-mail: tayvaz@pamukkale.edu.tr
[2]Department of Environmental Engineering, Dokuz Eylul University, TR-35160 Buca-Izmir, Turkey, e-mail: alper.elci@deu.edu.tr

This study proposes a linked simulation-optimization model for solving the groundwater pumping cost minimization problem for satisfying any given water demand. The proposed model integrates MODFLOW-2000, a modular three-dimensional finite difference groundwater flow model, with the heuristic harmony search (HS) optimization algorithm. HS is a recently proposed heuristic optimization algorithm which gets its computational basis from the musical improvisation processes. Since the solution was obtained by a heuristic algorithm, the optimization process starts with a randomly generated initial solution. Thus, it is not essential to define an initial estimate that is close to the final solution.

Using the proposed model, a pumping cost minimization problem was solved for different number of wells by considering the pumping rates as well as the well locations of additional new wells as the decision variables. Some physical and managerial constraints are defined for this problem. These constraint that need to be satisfied in the optimization process are set up such that hydraulic head values at the proposed well locations must not have a negative value, the depth of the proposed wells must not exceed a permissible limit, amount of the pumped water must not be lower than the given water demand, and locations of the proposed wells must not be placed into any inactive gridcells within the finite difference model domain. All of these constraints were included in the optimization model using thepenalty function approach.

Finally, the performance of the proposed model is evaluated on groundwater flow model of the Tahtalı watershed (Izmir-Turkey), an urban watershed which is a key component of Izmir's water supply system. Results indicate that the proposed simulation-optimization model was found to be efficient in identifying the optimal numbers, locations, and pumping rates of the pumping wells for satisfying the given constraints. Results also imply that the model is not only capable of obtaining any kind of mathematically plausible solution but a realistic one that can be confirmed by repetitive runs of the model.

Seepage tracing by stable isotopes and groundwater modelling: Example of Plavinas hydro power plant, Latvia

Alise Babre[1], Konrads Popovs[1], Aris Andersons[1], Martins Grava[2] and Aija Delina[1]

[1]Faculty of Geography and Earth sciences, University of Latvia, Alberta street 10, Latvia, e-mail: alise.babre@lu.lv
[2]Hydrotechnic buildings department at Plavinu HPP, Latvenergo, Energetiku street 2, Aizkraukle, LV-5110, Latvia, e-mail: martins.grava@latvenergo.lv

Plavinu hydroelectric power plant (HPP) built on river Daugava is the largest in the Baltic States and the second largest in European Union. Its annual production of electricity is up to 1991 GWh (in the year 2010). It covers around 30-40 % of total generated electricity in the country.

Relative difference between upstream and lower stream level is 40 m. Reservoir covers an area of 35 km^2, with total water volume of 509 mlj. m^3 in it. Building of a dam rapidly changed surrounding and large areas occurred under water after power plant begun to work. As well it changed hydrogeological conditions - some aquifers became more affected and water from reservoir could penetrate in some aquifers at particular distance. Due to high hydraulic gradients and high water saturation of aquifers extensive artificial discharge of groundwater is maintained to relief high pressures under construction.

Plavinu HPP is situated on ancient valley that is characterized by heterogeneous and complicated geological setting, where several geological layers are missing or pinched out. Several aquifers are tightly connected trough fractures or due to missing of low permeability sediments. All this lead to situation that source of artificially discharged water from aquifers can't be easily detected.

Thereby water stable isotopes were used to track possible origin of discharged water. Sampling procedure was organized to cover one year period collecting samples monthly and it took part from March 2011 till March 2012. Totally 55 samples were collected for stable oxygen and deuterium content in surface and groundwater samples, thus from upper and lower stream, 5 monitoring wells and one discharge collector. Sampling was maintained using bailer type sampler to take sample in particular depth. Samples for stable isotopes were analyzed in the Institute of Geology at Tallinn University of Technology.

Additionally mathematical hydrogeological model was developed to give more complete picture about hydrogeological conditions of study area and to evaluate and estimate surface - groundwater interaction. Calibrated mathematical hydrogeological model has already been developed previously for this study area (Bethers et al., 1998), although taking into account new geological data as well as new water level monitoring data set and different application of the model has been enhanced considerably.

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The effect of soil type and geochemical properties on pathogen transport in an esker aquifer – A column study

S. Backnäs[1], A. Kauppinen[2], N. Hyvärinen[3], T. Pitkänen[2], A-M. Hokajärvi[2] and I. T. Miettinen[2]

[1]Geological Survey of Finland, P.O. Box 1237, FI-70211 Kuopio, Finland, e-mail: soile.backnas@gtk.fi
[2]National Institute for Health and Welfare, Department of Environmental Health, Water and Health Unit, P.O. Box 95, FI-70701 Kuopio, Finland
[3]University of Eastern Finland, Department of Environment Science, P.O. Box 1627, FI-70211 Kuopio, Finland

Pathogenic microbes can migrate from a contamination source through soil to groundwater aquifer where they can enter drinking water and infect humans. In Finland about 90 % of the waterborne epidemics have been associated with groundwater source. We studied the transport of three enteric microbes: norovirus, MS-2 bacteriophage and *Escherichia coli* (*E. coli*), through laboratory columns packed with different gravel and sand materials taken from an esker formation. The column tests were performed in saturated conditions with varying flow velocities. KBr was used as a conservative tracer for determination of soil dispersion. Ammonium acetate-, ammonium oxalate- and aqua regia extractable trace elements were analyzed to characterize the soil geochemical properties. Also soil pH and organic matter and carbon contents were analyzed. The HYDRUS-1D code was used to analyze tracer and pathogen transport data and determine transport parameters from the breakthrough curves.

The results show that in general *E. coli* was retained more effectively than norovirus and MS-2. For norovirus and *E. coli* the effect of flow velocity was minimal compared to the effect of soil granularity e.g. the smaller the grain size the higher removal rate of the microbes was observed. In addition, the soil geochemical composition had an effect to the retention of the microbes in soils with similar granularity. On the contrary, for MS-2 the flow velocity and geochemical composition e.g. amount of reactive solid surfaces played a central role in the retention mechanism. The results of the study offer new information of pathogen removal in soil passage for pathogen transport modeling and groundwater risk assessments in Finnish esker aquifers.

Multivariate analysis of the relationship between volume and time duration of the flood waves

Veronika Bačová Mitková, Dana Halmová and Pavla Pekárová

Institute of Hydrology, SAS Račianska 75, 831 02, Bratislava 3, Slovakia, e-mail: mitkova@uh.savba.sk, halmova@uh.savba.sk, pekarova@uh.savba.sk

The catastrophic floods have various effects on the environment and economics not only in the past but also at present. In a number of cases a description of the probabilistic properties of hydrological variables is made on a single variable. It means that the discharges of flood waves or volumes of flood waves are statistically analyzed separately. But, flood is multidimensional hydrological event composed from some characteristic variables: discharge, volume and duration. Therefore, analysis of the flood wave requires multivariate statistical approach. The concept of multidimensional analysis relaxes the restriction of the traditional one-dimensional flood frequency analysis and connects one-dimensional marginal distribution of random variables with their joint distribution. Good tools for multivariate analysis of the statistical data are copula functions. A copula function as mathematical technique offers a flexible way of describing nonlinear dependence among multi-variate data in isolation from their marginal probability distributions, and serves as a powerful tool for modeling as well as simulating nonlinearly interrelated multi-variate data.

In our work we focus on the multidimensional statistical analysis of the flood waves on the Danube River in Bratislava gauging station, during period 1876-2006. The model was applied to the joint modeling of the time duration of the waves and volume of the waves on the Danube River. Archimedean copula functions were used in joint modeling. Copula parameters were estimated using mathematical relationship between Kendall`s coefficient of correlation and generating function. Results obtained by the multidimensional analysis of the hydrological variables, can contribute to more reliable assessment of flood risks. They give an overview of the flood event as a whole and practical use of these results can be in water management and in the design of flood protective systems.

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Influence of agricultural production in catchment to reservoir water quality and priorities for action

Sima Belic, Andelka Belic and Radovan Savic

University of Novi Sad, Faculty of Agriculture, Department for Water Management, 21000 Novi Sad, Trg Dositeja Obradovica 8, Serbia, e-mail: anbel@polj.uns.ac.rs

Water reservoirs are the primary source of freshwater for most settlements in northern part of Serbia. To monitor the dynamic changes in reservoir water quality, however, an innovative platform that is able to observe the entire reservoir with both high-spatial- and high-temporal-resolution is needed (Chang et al, 2009). Zobnatica reservoir has been made by building earth dam. Although this reservoir is multiple purpose facilities which, according to the FAO classification, fall in the category of service reservoirs. The basic reason for its building in the region of northern Serbia was the need for irrigation. Furthermore, Zobnatica reservoir is used to variable extent for fishery and recreation activities. The reservoir has been established on water stream whose catchment area includes considerable portions of agricultural land. This affects directly the mode and intensity of water quality changes. An ecosystem approach is based on the fact that the significance of the ecosystem for a land user can be clarified on the basis of „ecosystem services“. These are processes or properties of the ecosystem, which are beneficial to society. The idea is that land use will become more sustainable if the user employs ecosystem services to their fullest extent. Leakage of the nutrients N and P from agricultural systems is causing major environmental problems at present (Falkenmark, 2007). The irrigation practice which tends to intensity agricultural production and which causes considerable changes in the method of use of agricultural land, brings about still more rapid changes which may ultimately prevent the use of water for the intended purpose.

This paper deals with catchment area of Zobnatica reservoir in which agricultural land takes the major portion. The actual characteristics of the catchment area, the climatic and other factors make it possible for the intensive agricultural production in the region. In that case, agriculture becomes non point source polluter of the analyzed area. Comparing the volume of use of mineral fertilizers with the contents of nitrates and phosphates in the reservoir water, their relations were observed. The prevailing climatic and pedological characteristics, in combination with the actual structure of land ownership and the exercised method of land use, make room for the occurrence of wind erosion. In the catchment area of the reservoir Zobnatica, 25-40 kg/ha of nitrogen are leached annually from arable land. An investigation showed that the rate of P_2O_5 leaching ranged from 0 to 14 kg/ha/year for light soil, and from 0.3 to 8 kg/ha/year for heavy soil. A management, control and optimisation of different agricultural production processes conducted in catchment area, are the basis of all measures for the protection of soil, ground and surface water. To minimize the effect of agricultural production as source of diffuse contamination, it is necessary to choose a specific approach to this agricultural region. It is particularly important to carefully estimate natural conditions and type of agricultural production in catchment area. Complex measures for protection imply a series of synchronized activities are given in conclusions.

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Flood scenarios for river stretches with ice blocking potential

Uldis Bethers, Juris Seņņikovs, Andrejs Timuhins and Aigars Valainis

Laboratory for mathematical modelling of environmental and technological processes, Faculty of Physics and mathematics, University of Latvia, 8 Zeļļu Str., Rīga, LV-1002, Rīga, Latvia, e-mail: bethers@latnet.lv

The problem of defining the flood events of different return period for the river stretches where several factors may be responsible for the flooding is addressed in this work.

The research is based on the experience in a practical case study for the lower part of the Gauja River in Latvia. The Gauja River (catchment area ca. 9'800 square kilometres) enters the southern part of the Gulf of Riga – rather shallow (mean depth 26 m) semi-enclosed part of the Baltic Sea. Case study included several steps which might be of their own interest: (1) building a digital terrain model (DTM) from the high resolution LIDAR data in combination with minor watercourses, ditches, dams, roads etc., (2) set-up of the one-dimensional hydraulic (MIKE 11) model for the calculation domain using the cross-section measurements of the river bed and DTM, (3) analysing the waterlevel and discharge time – series of around 50 years, both to determine the flooding factors and to calculate the characteristics (boundary conditions) for the flooding events of different return period, (4) selection of the calibration cases and calibrating the hydraulic model, (5) calculation of river hydraulics for the flood risk scenarios of different return period, (6) mapping the flooded territories of the elevations calculated a calibration development of the flood risk scenarios, (7) introducing several engineering flood-defence solutions and (8) testing their effect on both the river hydraulics and flooded areas.

The lower stretch of the Gauja river is a challenging issue for the development of flood risk scenarios of different return period because there are at least three processes being responsible for the high water events. First, there are storm surges during the autumn-winter storms. A simplified scenario of the severe storm can be described as (1) transport of the water from the open Baltics into the Gulf of Riga during the initial and middle phases with prevailing SW-W winds and (2) water level set-up in the southern part of the Gulf of Riga (including the Gauja River estuary) in the end phase of a storm with prevailing NW wind. Second, there are spring snow melt floods with extremely high discharge values. Third, there are spring snow melt events characteristic with the low or medium discharges but extremely high water levels due to the ice blockage.

The water level (h) time series (daily values) were available in the modelling domain (5 km from the estuary), whilst the discharge (Q) time series – further upstream, i.e. in the stretch unaffected by either sea waterlevel or ice blockage. The statistics of the ice blockage (exact location, length) was not available. The analysis of Q-h relation was performed identifying the different events – extreme water levels caused by storms, extreme water levels caused by ice blockage and extreme water levels caused by high discharge values.

The scenarios for storm surges of different return period were treated as independent, and their return period calculated from extreme analysis of time series of sea level maxima. The following approach was proposed for the construction of the spring snow melt events of the different return period: (1) the separate extreme analysis was performed for the time series of maximum discharge Q and maximum river waterlevel h, (2) the artificial event with the same Q and h return period was assumed as the spring flood of that return period, (3) the calibration of the hydraulic model was performed for this artificial Q-h situation. The approach allows overcome a problem of ice blockage accounting in the hydraulic model (as MIKE11). It produces an artificially increased bottom roughness elsewhere in the modelling domain, thus avoiding a need to specify the exact location of the ice blockage. Instead, a potential ice blockage for the vulnerable stretch is accounted integrally.

Modelling of soil water conditions as an indicator for predicting landslides in Norway

Søren Boje[1,2], Stein Beldring[2] and Chong-Yu Xu[1]

[1]Department of Geosciences, University of Oslo, Norway,
e-mail: sorennb@student.matnat.uio.no
[2]Hydrology Department, Norwegian Water Resources and Energy Directorate (NVE),
P.O. Box 5091 Maj., N-0301 Oslo, Norway

Every year debris avalanches in Norway cause damage to infrastructure and housing and in rare cases even human lives are lost. Awareness from the Norwegian authorities to landslide occurrences in general has increased in recent years, which in 2009 led to the initiation of a regional scale debris avalanche warning service covering all of mainland Norway. The most important single factor triggering landslides is generally accepted to be groundwater (Waltham, 2002, p. 66). In most cases no observed data concerning groundwater conditions at the slide site is available. However, local discharge and meteorological records may help to clarify the possibilities for individual slide events (Voight and Pariseau, 1978, p. 15). Studying the hydrological conditions by using meteorological input data to simulate the water balance elements might indicate unique hydrological conditions at the event of a landslide. The right basis for such a study would be to use a hydrological model containing a detailed and physically sound description of the saturated and unsaturated soil water properties, including a good description of the groundwater movement.

A modified version of the hydrological model KiWa described in Beldring et al. (2000) has been selected in the study to simulate soil moisture condition and groundwater table, which, in turn, were used as indicators for triggering events of landslides. The model was applied to 12 catchments in southern Norway with observed hydro-meteorological data varying from 4 years to 8 years. The study region is dominated by a shallow layer of till deposits overlying impermeable bedrock generating a downslope groundwater movement. The first objective of the study has been to verify the performance of the original and modified KiWa model by adding elevation bands in the model structure to such regions in order to take into account the altitude gradients of temperature and precipitation. The second objective has been to identify possible hydrological conditions simulated by the model, which could be useful as indicators for triggering events of landslides.

The results show that the modified KiWa performed well in simulating river discharge with Nash-Sutcliffe model efficiency coefficients ranging from 0.57 to 0.88 of the 12 tested catchments. In addition 49 landslide events have been selected from the Norwegian database www.skrednett.no within the years 2000 to 2008. Only landslides occurring within a distance of 25 km from the centre point of one catchment were included. The simulated groundwater level was found to be a good indicator for the landslide events. It was found that 71 % of the landslide events were indicated by extreme hydrological conditions. When disregarding landslide events during winter season, the number increased to 89 % of the events.

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A strategy for addressing the impacts of climate change and urbanization on storm water quality in northern Sweden

Matthias Borris[1], Maria Viklander[2], Camilla Westerlund[3] and Anna-Maria Gustafsson[4]

[1,2,3,4] Department of Civil, Environmental and Natural Recourses Engineering, Luleå University of Technology, S-971 87 Luleå, Sweden

Urban storm water is recognized as a significant source of pollution heavily impacting the water quality of many receiving environments. The quality of storm water depends on several factors, especially the type of land use and precipitation characteristics. If those factors change due to climate change and a higher level of urbanization, it is likely that the quality of storm water change as well. Climate change is one of the biggest future challenges leading to changed hydrological conditions especially in urban areas. Global climate models show an increasing trend in averaged precipitation over the next century. In the northern part of Sweden the hourly rain fall maxima will increase, especially during spring and autumn. At the same time many areas will face an increased urbanization. Right now about 50% percent of the world population is living in cities, in 2050 it will be about 70%. Combined effects of high intensity rain and urbanization will have a dramatic effect on the hydrologic conditions as well as the pollution generation in urban areas. Increasing rainfall intensities and more impervious areas will affect the runoff process being more rapid and creating higher peak flows. Together with a higher abundance of pollutants this will change the transport capacity of pollutants. Consequently there is an interest in assessing possible future trends in order to develop adaptation strategies and to install suitable and well-designed measures. Such assessment has to be based on computer simulations for different climate change and urbanization scenarios. The aim of this study is to develop a strategy allowing examining combined effects of climate change and urbanization on simulated storm water quality in northern Sweden.

Today most advanced urban runoff models are capable to simulate the generation of urban storm water with a high level of certainty. Their performance to simulate storm water quality is less advanced but still satisfactory. These models reflect our current understanding of the most influential factor governing storm water quality. Therefor they represent a powerful tool for the study of potential changes in storm water quality due to a changing climate and urbanization.

A preliminary strategy has been developed and work has started on examining the sensitivity of the simulated storm water quality to the factors described above. The early findings indicate that the percentage of impermeable areas has a significant effect on the transport capacity of pollutants. Especially areas with a low level of imperviousness are sensitive to changes regarding climate and urbanization. Once the proposed strategy has been fully established, it will be further tested for a wide range of catchment and climatic conditions in order to give more definite answers.

Regional groundwater flow modelling of aquifer-peatland interactions. A case study from the Lanoraie Peatland complex Quebec, Canada

Marc-André Bourgault[1], Marie Larocque[1] and Roy Martin[1]

[1]Département des sciences de la Terre et de l'atmosphère, Université du Québec à Montréal et Centre de recherche pour l'étude et la simulation du climat à l'échelle régionale, Montréal, Québec, Canada, e-mail: marc-andre.bourgault.2@uqam.ca, larocque.marie@uqam.ca, roy.martin@uqam.ca

Links between peatlands, aquifers and rivers have received little scientific attention. Peatlands play an important role in preventing surrounding aquifer drawdown and river baseflow during drought periods (Kværner et al, 2006). This study focuses on the Lanoraie wetland complex (≈76 km^2, southern Quebec, Canada), which developed in former fluvial-channel beds that were formed during the final stages of the last deglaciation. This site is used to characterize the contribution of an unconfined deltaic sandy aquifer to the large peatland which occupies most of the wetland complex and its surrounding river network. A 3D hydrostratigraphic model was developed using the areal and vertical distribution of the main stratigraphic units, which were obtained from field observations and databases. The model was built by combining a volumetric approach and a relative thickness approach in the GMS 8.1 environment. Combined with a potentiometric map of the area, this conceptual model has allowed the identification of four main aquifer-peatland-river interactions in the different areas of the peatland complex: (1) centred radial flow along topography from the deltaic aquifer to the minerotrophic zone; (2) centred radial flow along peatland topography from ombrotrophic zone to minerotrophic zone (3) flow along the peatland elongation axis feeding the surrounding river network and (4) unidirectional flow from the peatland to the deltaic aquifer. Past studies provide hydrodynamic parameters for the sand aquifer and the organic deposits. Slug tests were performed in piezometers to provide additional hydraulic conductivities for peat and sand. Hourly water table fluctuations were monitored using INW sensors at nine sites within the peatland complex and used to calculate monthly evapotranspiration using diurnal variations method. River flows were measured at seven locations. Numerical simulations were performed using the MIKE SHE model, a fully-coupled groundwater-surface water modelling system (Refsgaard et al, 2010). The model is calibrated in steady state using average groundwater levels monitored during the summers of 2005, 2006, 2007 and 2011 and river flows measured during the summer of 2011. Aquifer-peatland exchanged fluxes are quantified over different portions of the wetland complex. Results confirm the flow directions and interaction types previously identified with the conceptual model. The model is now being used to simulate climate change scenarios and peatland perturbation scenarios.

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The effects to water quality of Efteni Lake (Turkey) as a buffer zone

Ahmet Çelebi[1,2], O.H. Dede[1] and Murat Sarginci[3]

[1]Sakarya university, Department of Environmental Engineering, TR-54187, Turkey, e-mail: ahmetc@sakarya.edu.tr
[2]University of Oulu, water resources and Environmental Engineering Laboratory, P.O. Box 4300, FI-90014 Finland
[3]Duzce University, Department of Forestry engineering, TR-81620 Turkey, e-mail: muratsarginci@duzce.edu.tr

Efteni Lake is within northwest area of Turkey and between latitudes 41° 50′ 00″ N to 40° 40′ 00″ N and longitudes 30° 50′ 00″ E to 31° 40′ 00″ E . This area has critical importance in many ways. Besides the biological richness of this bufferzone, it is located on a hydrological special area. The lake is intertwined with Melen River which is planned to fulfill the water needs of important cities.

There are several processes in water, vegetation and soil, which affects retention efficiency in buffer zones (BZs): (1) deposition of sediments and sediment-bound nutrients, (2) uptake of nutrients by vegetation, (3) infiltration of surface water into the soil and (4) adsorption of nutrients to soil and vegetation (Barling and Moore, 1994 and Mander et al., 1997).

The main purpose of this study is to investigate the effects to water quality, where all inflow-inside area and outflow (Bigger Melen River) to Buffer Zone. This study is the first to reveal hydrological importance of the field differentially.

In this study water quality parameters of the spring water (inflow-outflow) are monitored during spring which has rapid flowering metabolic activities. Flow rates are measured and samplings are made. Basic water quality parameters (pH, electrical conductivity , dissolved oxygen, total dissolved solids, resistevity, salinity and temperature) were measured in the field. Metals (Aluminium, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silver , Sodium, Thallium, Vanadium and Zinc) were analyzed (standard methods EPA 200.7, ISO 11885) using Inductively coupled plasma in the laboratory.

The results show that the bufferzone had overall positive effect on water quality. Vanadium and molybdenum metals decreased on the outflow even beginning of spring. pH decreased slightly but always was higher than 7, dissolved oxygen (from 10 mg/L to around 3 mg/L) and saturation dramatically decreased during spring time.

As a result Efteni wetland has an important location and it deserves to be protected and monitored even for its positive effects on water quality.

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Seasonal and temporal variation of metal contamination in groundwater in Melen watershed (Turkey)

Ahmet Çelebi[1,2] and Bulent Sengorur[1]

[1]Sakarya university, Department of Environmental Engineering, TR-54187, Turkey, e-mail: ahmetc@sakarya.edu.tr
[2]University of Oulu, Water Resources and Environmental Engineering Laboratory, P.O. Box 4300, FI-90014, Finland

Groundwater is the water contained beneath the surface in rocks and soil and is the water that accumulates underground in aquifers. groundwater constitutes 97 percent of global freshwater and is an important source of drinking-water in many regions of the world. in many parts of the world groundwater sources are the single most important supply for the production of drinking-water, particularly in areas with limited or polluted surface water sources (Schmoll et all 2006). In our study area groundwater is also important since using drinking-water.

This research study area Melen Watershed located at the western part of the Black Sea Region (latitudes 41° 5′ 00″ N to 40° 40′ 00″ N and longitudes 30° 50′ 00″ E to 31° 40′ 00″ E). It covers a total area of 2,437 km^2. Since it is facing rapid industrialization it is a dispersed habitat. Groundwater is mostly the drinking water supply in the rural area. Sampling points were determined considering industrialization. Seasonal quality of the underground water was monitored. Our aims for this study are to determine critical points and period of high load and to determine pollution sources.

Basic water quality parameters (pH, electrical conductivity, dissolved oxygen, total dissolved solids, resistevity, salinity and temperature) were measured in the field. Metals (Aluminium, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silver , Sodium, Thallium, Vanadium and Zinc) were analyzed (standard methods EPA 200.7, ISO 11885) using Inductively coupled plasma in the laboratory.

Our study is the first in terms of selected sampling points and monitored parameters. The obtained levels of dissolved metals, such as the chromium found significantly close to the groundwater at Organized Industrial Zone, prove contamination. It is inevitable that pollution will increase with industrialization. Based on obtained results it can be affirmed that there is groundwater contamination in the watershed. Arsenic, Zinc, Boron, Copper, Vanadium, Barium especially demand attention due to their effects on Human Health. They must be monitored. As a season, ”Autumn” present the most risk in terms of metal pollution. Contamination is more evident in areas closer to industrial regions. Industrial discharge control must be done more often and properly. Environmental impact assessment should be done sensitively in the planning process. Monitoring the effects on water quality and the public health is required.

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Climate change in a part of Northern Europe in the context of the spatial differences of the contemporary climate

Daiga Cepīte-Frišfelde[1], Tija Sīle[1], Uldis Bethers[1], Juris Seņņikovs[1] and Andrejs Timuhins[1]

[1]Laboratory for Mathematical Modelling of Environmental and Technological Processes, University of Latvia, Riga, LV-1002, Zellu Str. 8, Latvia, e-mail: daiga.cepite@lu.lv

The authors have proposed a function measuring the climate difference between arbitrary terrestrial locations in Cepīte-Frišfelde et al. (2012). In this work an extended application of that approach is considered. The present study illustrates climate change in the period 1951-2100 of a particular region in Northern Europe where the temporal change is described using the spatial climate differences of the contemporary climate in Europe.

The particular region of interest includes the territory of Estonia, Finland, Latvia and Lithuania. To compare the temporal climate change with the spatial climate variation in the fixed period of time the method of defining the quantitative difference between the climates of any two points in the world is used. The quantitative climate distance is obtained using 30-year long time series of the gridded monthly average temperature and precipitation rates. The method has been initially presented in Cepīte-Frišfelde et al. (2012) where territories with contemporary climate similar to the climate in Latvia in the periods 2021-2050 and 2071-2100 are identified. In the present study the region of interest is widened and a more detailed analysis is carried out. On the map imaginary patterns of the movement of the territories and cities representing the temporal change in time have been analysed.

The data describing temporal change of the monthly average temperature and precipitation rates is acquired from an ensemble of the bias corrected climate projections. The median values from a set of the monthly averages are acquired from the European Commission's 6th Framework Programs five year Integrated Project ENSEMBLES results, see ENSEMBLES members (2009) for detail. The bias correction method implemented in the study is proposed by Sennikovs and Bethers (2009). The contemporary climate is characterised using a number of sources depending on the scope of the analysis. The data used are the gridded reanalysis data provided by ECMWF (European Centre for Medium Range Weather Forecasts), the BaltAn65+ high-resolution regional reanalysis from the University of Tartu and the set of observation data series for daily temperature and precipitation rates in the Baltic region.

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Integrating a Typhoon Event Database with an Optimal Flood Operation Model on the Real-Time Flood Control of the Tseng-Wen Reservoir

Yu-Wen Chen[1] and Liang-Cheng Chang[2]

[1]Post-Doctoral Researcher, Department of Civil Engineering, National Chiao Tung University, Hsinchu City, Taiwan, e-mail: bsjacky@gmail.com
[2]Professor, Department of Civil Engineering, National Chiao Tung University, Hsinchu City, Taiwan, e-mail: lcchang31938@gmail.com

Typhoons, which normally bring a great amount of precipitation, are the primary natural hazard in Taiwan during flooding season. Because the plentiful rainfall quantities brought by typhoons are normally stored for the usage of the next draught period, the determination of release strategies for flood operation of reservoirs which is required to simultaneously consider not only the impact of reservoir safety and the flooding damage in plain area but also for the water resource stored in the reservoir after typhoon becomes important.

This study proposes a two-steps study process. First, this study develop an optimal flood operation model (OFOM) for the planning of flood control and also applies the OFOM on Tseng-wun reservoir and the downstream plain related to the reservoir. Second, integrating a typhoon event database with the OFOM mentioned above makes the proposed planning model has ability to deal with a real-time flood control problem and names as real-time flood operation model (RTFOM). Three conditions are considered in the proposed models, OFOM and RTFOM, include the safety of the reservoir itself, the reservoir storage after typhoons and the impact of flooding in the plain area. Besides, the flood operation guideline announced by government is also considered in the proposed models. These conditions and the guideline can be formed as an optimization problem that is solved by the genetic algorithm (GA) in this study. Furthermore, a distributed runoff model, kinematic-wave geomorphic instantaneous unit hydrograph (KW-GIUH), and a river flow simulation model, HEC-RAS, are used to simulate the river water level of Tseng-wun basin in the plain area and the simulated level is shown as an index of the impact of flooding. Because the simulated levels are required to re-calculate iteratively in the optimization model, applying a recursive artificial neural network (recursive ANN) instead of the HEC-RAS model can significantly reduce the computational burden of the entire optimization problem.

This study applies the developed methodology to Tseng-wun Reservoir. Forty typhoon events are collected as the historical database and six typhoon events are used to verify the proposed model. These typhoons include Typhoon Sepat and Typhoon Korsa in 2007 and Typhoon Kalmaegi, Typhoon Fung-Wong, Typhoon Sinlaku and Typhoon Jangmi in 2008. The results show that the proposed model can reduce the flood duration at the downstream area. For example, the real-time flood control model can reduce the flood duration by four and three hours for Typhoon Korsa and Typhoon Sinlaku respectively. These results indicate that the developed model can be a very useful tool for real-time flood control operation of reservoirs.

A regionalized spatial-temporal point process model of rainfall for the Basque Country, Spain

Paul Cowpertwait[1], David Ocio[2], Guillermo Collazos[2], Oscar de Cos[2] and Christian Stocker[3]

[1]School of Computing and Mathematical Sciences, Auckland University of Technology, NZ.
[2]Sener Ingeniería y Sistemas S.A. Zugazárte, Getxo, Spain
[3]Agencia Vasca del Agua, Vitoria-Gasteiz, Spain

A spatial-temporal point process model of rainfall is developed for flood studies in the Basque Country, Spain. The proposed model has two storm types to allow for convective and stratiform rain and is a special case of the spatial-temporal model developed by Cowpertwait (2010). In this model, storms occur in a spatial-temporal Poisson process and have radii that are independent exponential random variables. The arrival times of raincells follow a Neyman-Scott point process and have spatial locations given by a Poisson process and radii that are independent exponential random variables. The model is fitted to hourly and daily data taken from three homogeneous contiguous regions identified in a previous study (Cowpertwait, 2011). It is found that once the regions are taken into account, altitude as an explanatory variable does not significantly improve the prediction of mean rainfall at a site.

A fitting procedure is proposed to ensure that the parameter estimates for each month vary smoothly over the year: (1) A sum of square differences between selected model functions and sample estimates for each calendar month is minimized – the selected model functions are the coefficient of variation, skewness, and lag 1 autocorrelation, at the 1, 6, and 24 h aggregation levels, and the proportion of dry days; (2) The parameters are re-estimated for each month using the mean estimates from adjacent months obtained in (1) as starting values and setting the bounds in the minimization procedure to ±50% of each starting value. (3) Step 2 is repeated to provide a distribution of estimates for each parameter and month – the median of this distribution is used as the final estimate of each parameter. (4) The model scale parameter is estimated from the sample mean rainfall for each month using the model function of the mean and the final estimates obtained in step 3. (5) The spatial parameters, for the storm and cell radii, are estimated from the sample cross correlations evaluated for all pairs of sites in a region at the 1, 6, and 24 h aggregation levels.

The model is fitted to data from 357 sites taken from each of the three homogeneous regions. A good fit is obtained to the statistical sample properties that are used in the fitting procedure. The model is validated by comparing statistical properties of the annual maximum discharges simulated through the TETIS distributed catchment model (Frances et al., 2007) with observed recorded discharges. The results indicate that the model will be of value in the forthcoming hydrological catchment studies.

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Riparian vegetation functioning in zones with low anthropogenic nutrient input

Jaime G. Cuevas[1], Christian Little[2], César Leiva[1], Leandro Paulino[3] and José Dörner[4]

[1]Instituto de Investigaciones Agropecuarias, Casilla 567, Valdivia, Chile, e-mail: jxcuevas@inia.cl
[2]Escuela de Graduados, Facultad de Ciencias Forestales y Recursos Naturales, Universidad Austral de Chile, Casilla 567, Valdivia, e-mail: little.christian@gmail.com
[3]Universidad de Concepción, Casilla 537, Chillán, Chile, e-mail: lpaulino@udec.cl
[4]Instituto de Ingeniería Agraria y Suelos, Facultad de Ciencias Agrarias, Universidad Austral de Chile, Casilla 567, Valdivia, Chile, e-mail: josedorner@uach.cl

Riparian vegetation (RV) is considered as a natural buffer that filters the influences from extra-riparian environments caused by forestry, agriculture, livestock, and direct human effects. The RV controls biogeochemical cycles, regulates and retains sediments that otherwise would go to the streams, regulates stream temperature, and controls the hydrological regime. In countries such as Chile, the protection of streams by RV is included in national regulations, but there is no literature background supporting a hypothetic buffer effect in these ecosystems. Moreover, there is no consensus about which stream properties should be protected including temperature, electrical conductivity, nutrients. It is relevant to study Southern Hemisphere ecosystems, such as those found in Chile, because they are scarcely disturbed by pollution (i.e., acid rain), which is often the case in North America and Europe. This allows assessing RV functioning as in pre-industrial times.

We studied RV functioning using a double approach:

1) Superficial waters: we evaluated runoff and nutrient and sediment concentrations as a function of streamside native forest width (SNFW) in streams draining eight watersheds dominated by exotic forest plantations located at 39° 57' S, 73° 35' W. Increases in SNFW had a positive relationship with the runoff coefficient. Multiple regression analyses showed that, besides precipitation, strip width was a statistically significant predictor of total nitrogen, dissolved inorganic nitrogen, and nitrate-N with β coefficients of -0.30, -0.34, and -0.40, respectively ($P < 0.05$). We did not find a significant effect for phosphorus. An inverse correlation was also found between SNFW and organic sand, inorganic and organic silt/clay with β coefficients of -0.19, -0.17, and -0.30, respectively ($P < 0.05$).

2) Underground waters: we studied groundwater quality in a transect going from some prairies to a third-order stream north of the city of Valdivia (39° 49' S). A 45-m wide strip of native forest grew on the slope and flooding plain that separated these ecosystems. Preliminary monitoring showed that nitrate-N decreased from a mean of 82 to 5 $\mu g\ N\ L^{-1}$, while ammonium-N increased in the same transect (7 to 212 $\mu g\ N\ L^{-1}$). Interestingly, a large variation in nitrate-N occurred beneath the prairie where the water table is > 7 m below-ground and thus out of root scope. This result suggests that the soil itself is also involved in the filtering effect. In fact, denitrification assays showed rates of -7 to 15 mg $N_2O\ ha^{-1}\ h^{-1}$, which are much lower than fertilized prairies and riparian forests studied elsewhere, but suggest that this process is partly responsible for nitrogen losses in the analyzed transects.

These results allow us to conclude that the width of the streamside covered by native forest does in fact have a buffer effect for water provision (quantity and quality) and supports decision-making related to the conservation and management of soils, streams, and adjacent riparian areas.

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Land use as a factor affecting flood characteristics in small catchments

Vaclav David[1] and Tereza Dvorakova[2]

Dept. Of Irrigation, Drainage and Landscape Engineering, Faculty of Civil Engineering, Czech Technical University in Prague, Thakurova 7, 166 29 Prague 6, Czech Republic
[1]e-mail: vaclav.david@fsv.cvut.cz, [2]e-mail: tereza.dvorakova@fsv.cvut.cz

Flood characteristics of small catchments are usually estimated using different methods ranging from simple conceptual equations to detail physically based hydrologic models as there is mostly lack of measured data which could be used for standard flood frequency analysis. Simple conceptual methods are represented for example by the rational formula introduced by Mulvaney (1851) while physically based models can be represented by Gridded Surface Subsurface Hydrologic Analysis (Downer and Ogden, 2006). The development of a method for estimations of flood characteristics of small catchments within large regions is a subject of research project COST LD11031. This method is supposed to be based on simple procedure to be applicable in large regions. Another requirement is the data availability and therefore it needs to be based on the analysis of general datasets.

Proposed method is simply based on the calculation of flood characteristics using different catchments properties which have significant influence on flood forming. It considers three main groups of characteristics which are morphology, land use and soil properties. The shape of the method is similar to the equations published by Olson (2009) but it takes into account more catchment properties. The influence of each catchment characteristic is necessary to be analyzed in detail to derive and quantify the relationship between each characteristic describing the catchment and each flood characteristic.

The land use affects flood characteristics in different ways. The analysis on it is presented in this paper. The volume of flood wave is affected mainly by the surface storage or canopy storage while the peak discharge as well as the time to peak is affected mainly by the surface roughness. It has been verified by the research carried out within the project that the influence of the land use is higher in case of shorter return periods than in case of longer return periods. The relationship between surface storage capacity, canopy storage capacity and surface roughness has been analyzed for three different catchments using hydrologic model GSSHA and different land use scenarios have been applied to cover the broad spectra of land use conditions. The results have been used for purposes of the methodology development.

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Impact of the Climate Change on the water resources of the Middle East

M. T.M. Dawoud, D. Bozkurt and O.L. Sen

Eurasia Institute of Earth Sciences, Istanbul Technical University, Maslak, Istanbul 34469, Turkey

The ICTP:RegCM3 model was used to downscale the ECHAM5 global circulation models 20C and A2 simulations for an area covering eastern Mediterranean: Black Sea regions and parts of the Middle East. The spatial resolution was chosen as 27km. The evaluation of the reference period (1961:1990) of the simulations was published in Bozkurt et. al. (2011). The future assessment is carried out for four countries in the Middle East, namely Syria, Lebanon, Jordan and Israel. For all these countries, the future simulations indicate approximately 2 °C increase in temperature for the mid 21st century and about 4:4.5 °C increase for the last 30: year period of the 21st century. Annual precipitation is projected to decrease substantially for Lebanon (about 17%) by the end of the present century. It is also simulated to decrease for Israel, but the reduction is comparatively small. For Syria and Jordan, the simulated precipitation changes are small and insignificant. The changes in surface runoff are mostly in line with the changes in precipitation. Lebanon is projected to have the largest reduction in surface runoff. The reduction for Israel is small but noticeable. For the other two countries, surface runoff changes are small.

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Baseflow contribution and diurnal variation in discharge; an example for a small agricultural catchment in Norway

Johannes Deelstra

Bioforsk – Norwegian Institute for Agricultural and Environmental Research, Frederik A. Dahls vei 20, 1432 Ås, Norway, e-mail: johannes.deelstra@bioforsk.no

Runoff behaviour in agricultural dominated catchments is determined by a number of factors like climate, land use, soil types, topography and size. Different flow processes are present in agricultural catchments. In many cases agricultural land has been provided with subsurface drainage systems having the objective to guarantee good cropping conditions while in addition facilitating land preparation in early spring and late autumn. It is a well known fact that subsurface drainage systems significantly contribute in runoff and nutrient loss. Another contributor in runoff processes is surface runoff, often responsible for erosion from agricultural land. In addition to the afore mentioned surface and subsurface runoff, a third component, being groundwater, is contributing in the total runoff. In measuring the total runoff at the catchment outlet, uncertainty exists concerning the contribution of the different flow processes in the total runoff.

A study, carried out by Deelstra et al(2010) showed that small agricultural dominated catchments can have a rather "flashy" nature in runoff behaviour, characterised by large diurnal variations in discharge. Flashiness in runoff, when expressed using a flashiness index (FI, Baker et al, 2001), showed a significant increase when calculated on hourly discharge values compared to average daily values. At the same time it was shown that catchments with a high flashiness index had a low baseflow contribution (BFI). In this case the BFI was calculated using average daily discharge values, in many cases the required input to ready-made programs for the calculation of the baseflow contribution. The question arises whether in calculating the BFI also the diurnal variation could be taken into account.

This paper presents the results for the calculation of the baseflow contribution when considering the diurnal variation in discharge, using a digital filter with one filter parameter (Chapman and Maxwell, 1996). A program in MATLAB was developed to calculate the BFI based on both average – and minimum daily discharge values. The filter was applied to runoff form an agricultural dominated catchment in Norway, having a size of 4.5 km^2, with agricultural land occupying approximately 60 % .

The value for the filter parameter, used in the digital filter, varied from 0.925 – 0.995. When using average daily discharge values as input, the BFI varied 46 – 18 % and, when using the minimum daily discharge, from 32 – 11 %. The results show a significant change in the BFI, indicating that using discharge values with a higher time resolution might give a more realistic impression of the BFI and thereby of the different flow contributions in the total runoff in agricultural catchments.

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Where in a river catchment are restoration efforts most effective?

Anna L. Dietrich[1], Christer Nilsson[2] and Roland Jansson[3]

[1]Landscape Ecology Group, Department of Ecology and Environmental Science, Umeå University, SE –901 87 Sweden, e-mail: anna.dietrich@emg.umu.se
[2]Landscape Ecology Group, Department of Ecology and Environmental Science, Umeå University, SE –901 87 Sweden, e-mail: christer.nilsson@emg.umu.se
[3]Landscape Ecology Group, Department of Ecology and Environmental Science, Umeå University, SE –901 87 Sweden, e-mail: roland.jansson@emg.umu.se

Many riparian ecosystems in northern Sweden have been impacted by structural measures to facilitate timber floating from the 19th and into the second half of the 20th century. Restoration efforts in the last decades have included relocation of boulders into the channel, dam and stone pier removal, and opening of cut-off side channels. The present project assesses where in a river catchment it is most effective to realize such restoration efforts. This is done by measuring the responses to restoration of basic ecological processes along a climatic and a stream order gradient in the Vindel River catchment. A total of 10 sites, each consisting of a pair of an impacted and a restored reach were selected in the tributaries and the main channel. We employed the phytometer approach by transplanting young individuals of the forb Filipendula ulmaria and the grass Molinia caerulea into the field and recording their reactions to the present conditions. Furthermore, germination and performance studies on soil extracted from the different sites were conducted in the greenhouse, and soil samples were analyzed to yield information about levels of plant nutrients.

Preliminary results from the field experiment after the first two growing seasons show a high between-site-variation and no clear patterns, neither in regard to the different gradients nor in terms of improvement of habitat conditions at restored sites. When comparing phytometer performance in the greenhouse, however, we detected that plants grown on soil extracted from restored sites responded with an almost significantly higher biomass production ($P=0.08$). Performance was especially high on soils from a higher elevation in the riparian zone, i.e. in a zone that is less frequently flooded. Environmental factors affected the different phytometer species differently. The biomass production of the forb, for example, was significantly correlated with length of growing season, whereas the grass showed a significant correlation with the amount of organic material present in the soil. We conclude that phytometers in the field will need more time to show clear patterns, particularly at lower elevations in the riparian zone where flooding lasts longer and is more frequent, implying a shorter effective growing season. Furthermore, there seems to exist a “memory effect” of the growing season in the soil that we hope a chemical analysis of the soil can shed light upon.

Development and utilization of GIS based groundwater discharge prediction method

Riku Eskelinen

Water Resources and Environmental Engineering Laboratory, University of Oulu, P.O. Box 4300, FIN-90014 Oulun yliopisto, Finland, e-mail: Riku.Eskelinen@oulu.fi

Objective of this research project was to develop a GIS based method for predicting locations where groundwater discharge occurs at esker surroundings. Model was further on examined for potential use in different applications i.e. as a tool for researchers to guide their studies to the critical areas, providing background information for decision makers when creating groundwater protection policies or as an aid when planning remediation for esker areas.

Input data for the model was collected from online GIS database 'PaITuli', Geological Survey of Finland and University of Oulu. Three different model scenarios were built to study how different input data affected the final results. Scenario 1 is composed of commonly available data (base map, DEM, natural springs, groundwater area boundaries) which makes it possible to be applied for whole Finland. Scenarios 2 and 3 added site specific data (peat thickness measurements, baseflow). These data are a result of long term studies and not available for all groundwater areas.

Result of the model was a map showing the risk potential of groundwater discharge in four different classes. Classes were set to 'low', 'med', 'high' and 'very high', where 'very high' presents most likely discharge location. Model was applied on two different locations; Rokua esker and Kivivaara esker. Rokua esker has been a subject for many studies in the past therefore plenty of data exists for GIS model. At Kivivaara only the commonly available data was used. After risk map was created the results were validated by carrying out field studies at selected areas of both eskers. Used validation methods were in situ inspection of risk areas, stream flow and temperature measurements and potentiomanometer measurements.

All of the scenarios built were able to predict the groundwater discharge locations but each scenario had a different kind of limitations in prediction accuracy or usability. Use of the model was helpful for finding the risk areas, but used method was not accurate enough to pinpoint exact discharge points. Risk maps were also used to make a draft of remediation plan for Rokua area. Using model as an aid for remediation plan was beneficial since it could provide a good estimate of the areas which need to be treated to give price for the remediation procedures.

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High-resolution multi-temporal contiguous mapping of river bed and flood-plain by combining laser scanning with UAV-photogrammetry based bathymetry

Claude Flener[1], Antero Kukko[2], Anttoni Jaakkola[2], Anssi Krooks[2], Matti Vaaja[3], Elina Kasvi[1], Harri Kaartinen[2], Hannu Hyyppä[3], Juha Hyyppä[2] and Petteri Alho[1]

[1]University of Turku, FI-20014 Turun yliopisto, Finland, e-mail: claude.flener@utu.fi
[2]Finnish Geodetic Institute, PL 15, FI-02431 Masala, Finland
[3]Aalto University, P.O. Box 11000, FI-00076 Aalto, Finland

Accurate terrain models are a crucial component of hydraulic modelling applications and studies of river channel evolution. Flood modelling, in particular, requires high quality terrain models of both the river bed and the flood-plain. Due to the technological differences of various data acquisition methods on land and under water, contiguous high resolution terrain model surfaces are still rarely produced. While aerial laser scanning based digital terrain models of relatively high resolution are becoming more widely available, in a fluvial context they only cover the river banks and flood-plain; the river bed is often no more than a coarse approximation of reality based on sonar points.

In this study we present a range of high-resolution mapping techniques that are combined to create a seamless terrain model of a meander bend of a sandy-bed river in Lapland. Boat-based mobile and terrestrial laser scanning was used to scan the river banks at a more favourable angle and higher resolution than can be achieved with aerial laser scanning. In addition, high-resolution aerial photography was acquired using a camera embarked on a low-flying unmanned aerial vehicle (UAV). The river bed was modelled using spectrally based bathymetric modelling techniques based on the UAV images. These images also provided a photogrammetry-based model of the flood plain. We constructed a contiguous terrain model of the study area with a 5 cm spatial resolution by combining these laser scanning and UAV-photography based mapping methodologies.

The differences in accuracy of the data created by these different mapping technologies were analysed with the aim to determine a minimal combination of methods according to the specific requirements of accuracy and resolution of practical applications.

Finally, we used data from two consecutive years to demonstrate the utility of the seamless terrain model by way of a highly detailed geomorphological change analysis of the river bend in question.

A comparison of different approaches for forecasting spring floods in Sweden and the feasibility of a multi-model forecast system

K Foster[1,2], J Olsson[1], C B Uvo[2], W Yang[1] and J Södling[1]

[1]Swedish Meteorological and Hydrological Institute, S-60176 Norrköping, Sweden, e-mail: kean.foster@smhi.se
[2]Department of Water Resources Engineering, Lund University, Box 118, S-22100 Lund, Sweden

In seasonally snow covered regions, such as Sweden, the winter precipitation often falls as snow which is temporarily stored in the snow pack during the colder months. This storage is later released over a relatively short period of intense flows during in the warmer months. These spring flood events dominate the hydrology of these regions and therefore there is a real interest in reliable hydrological forecasts of these events.

In this study, three different ensemble forecast approaches to spring flood forecasting were compared to the state-of-the-art operational method. (1) A reduced historical ensemble approach, where analogue years from the historical dataset are selected to run the hydrological model. (2) Using meteorological seasonal forecasts from the European Centre for Medium-Range Weather Forecasts (ECMWF) to run the hydrological model. (3) Statically downscaling large-scale circulation variables from ECMWF seasonal forecasts to accumulated discharge using the Singular Value Decomposition method. The different approaches were evaluated for forecasts issued on 1/1, 1/3 and 1/5 for the spring floods 2000-2010 in the rivers Vindelälven, Ångermanälven and Ljusnan. The evaluation was mainly performed in terms of the mean absolute error (MAE) of accumulated discharge with the state-of-the-art forecast as a reference. Also the frequency of cases when the new approach outperformed the state-of-the-art forecast was calculated and used.

From the different approaches the feasibility of a multi-model forecast system is investigated for more robust forecasts.

Long term variability of Swedish river runoff as represented by EC-EARTH in past and future climates

Kean Foster[1,2], Olena Siergieieva[1], David Correl[1] and Cintia B. Uvo[1]

[1]Department of Water Resources Engineering, Lund University, Box 118, 221 00 Lund, Sweden
[2]Swedish Meteorological and Hydrological Institute, S-601 76 Norrköping, Sweden, e-mail: kean.foster@smhi.se

The aim of this work is to investigate the long term variability of seasonal runoff in past and future climates (1851-2100) for selected Swedish rivers by analysing river runoff data downscaled from large scale circulation variables (LCV), from the EC-EARTH climate model, using a SVD (singular value decomposition).

LCVs from historical runs (1851-2005) of the EC-EARTH climate model together with observed runoff time series are used to train the SVD. The trained SVD is then used to downscale LCVs from EC-EARTH climate runs (2006-2100). Quantitative and qualitative analyses of the long term variation of both downscaled data series, both past and future, are used to compare the changes in variability between the two periods.

Regionalisation of Swedish hydrology

Kean Foster[1,2] and Cintia B. Uvo[2]

[1]Swedish Meteorological and Hydrological Institute, S-60176 Norrköping, Sweden, e-mail: kean.foster@smhi.se
[2]Department of Water Resources Engineering, Lund University, Box 118, S-22100 Lund, Sweden

Efficient water resource management is dependent on good quality and timely information. The aim of this work is to both divide Sweden's hydrology into homogeneous hydrologic response regions and to understand the underlying mechanisms of each regions hydrologic signature.

The aim of this work is a qualitative and quantitative analysis of river discharge and discharge variability at the seasonal to decadal timescale and to seek out the mechanisms that account for this variability. River runoff data from over 100 selected stations across Sweden will be used together with data from known climate patterns. This work is intended to be a foundation for both water resource management and future hydrological research endeavours.

PERSiST: The Pan European Runoff Simulator for Solute Transport

Martyn Futter[1], Dan Butterfield[2], Øyvind Kaste[3], Jostein Starrfelt[3], Martin Erlandsson[4] and Andrew Wade[4]

[1]Swedish University of Agricultural Sciences, P.O. Box 7050, Uppsala, Sweden, e-mail: martyn.futter@slu.se
[2]EnMoSys, Chicago, IL 60137, USA, e-mail: dan.butterfield@gmail.com
[3]NIVA, NO-0349, Oslo, Norway, e-mail: oyvind.kaste@niva.no, jostein.starrfelt@niva.no
[4]Reading University, RG6 6AB, Reading UK, e-mail: m.a.erlandsson@reading.ac.uk, a.j.wade@reading.ac.uk

Here we present a new rainfall runoff model for biogeochemical modelling. PERSiST, the Pan-European Runoff Simulator for Solute Transport is a semi-distributed model operating at a daily time step. The model simulates runoff at one or more points in a river system using inputs of catchment characteristics and daily temperature and precipitation time series.

The model has been designed to simulate hydrological conditions in boreal, temperate and Mediterranean catchments over time periods of 1 to 100+ years. PERSiST simulates both terrestrial and in-stream controls on runoff. Processes simulated include snowmelt, evapotranspiration, riparian zone infiltration and inundation and biogeochemically important summer low-flow events. PERSiST is able to simulate the effects of different land uses and land covers on runoff generation. The manner in which precipitation is routed through the catchment is extremely general. Depending on the manner in which the model is set up, it is possible to simulate riparian zones, drain flow, and water abstraction.

Preliminary model applications have been made to catchments in Sweden, Norway, Finland, Canada, the UK and Spain. Initial results are encouraging. In some cases, Nash-Sutcliffe model efficiencies of 0.8 have been achieved. The best simulations have been achieved in boreal and temperate catchments. Further work is required to improve model performance in Mediterranean catchments and to assess model sensitivity.

Modelling long-term patterns in suspended sediment in a mixed land use Swedish catchment

Martyn Futter[1], Stefan Hellgren[1] and Faruk Djodjic[1]

[1]Department of Aquatic Science and Assessment, Swedish University of Agricultural Sciences, P.O. Box 7050 Uppsala, Sweden, e-mail: martyn.futter@slu.se, stefan.hellgren@slu.se, faruk.djodjic@slu.se

Erosion and transport of suspended solids is in Sweden rarely of such magnitude to be considered a serious large-scale environmental problem. In some cases, however, suspended solids and increased turbidity have direct negative effects on aquatic ecosystems. However, the suspended material as a carrier of nutrients, mainly phosphorus, and other substances (such as metals, pesticides, organic pollutants, etc.) is very important for the total transported amounts of these substances.

Here we present the results of two model applications to the Sävjaån, a river draining a mixed land-use catchment near Uppsala, Sweden. We used FyrisQ (Djodjic et al. 2012) and INCA-Sed (Lazar et al. 2010) to simulate different aspects of hydrology and sediment production and transport in the catchment.

Two interesting relationships were observed in the FyrisQ simulations. Higher levels of suspended solids in the river were associated when wetter conditions prevailed in the watershed. Elevated suspended sediment concentrations were also observed during snow melt.

The INCA-Sed application was the first time this model has been applied in Sweden. INCA-Sed simulations corroborated the findings of the FyrisQ simulations. The INCA-Sed application showed the importance of snow melt and wet summer conditions as drivers of high suspended sediment concentrations. Using INCA-Sed, it was also possible to show the importance of lakes as sinks for suspended sediments. While this is a preliminary model application, it does show that INCA-Sed is a useful tool for increasing the understanding of sediment mobilization and transport under Swedish conditions.

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Source based estimation of pollutant flushes in mixed urban catchments Uncertainties in pervious-impervious surface runoff modeling

Helen Galfi, Camilla Westerlund, Gilbert Svensson and Maria Viklander

[1]Department of Civil, Environmental and Natural Resources Engineering, Lulea University of Technology, S-971 87 Lulea, Sweden, e-mail: helen.galfi@ltu.se
camilla.westerlund@ltu.se, gilbert.svensson@ltu.se, maria.viklander@ltu.se

Source based modeling of storm water quality can give a fair approximation of pollutant emissions and fate from different impervious surfaces and activities in urban environments. Uncertainties in modeled concentrations are connected mainly to undeveloped, pervious areas and sewer processes within the modeled catchment. Although the impervious components of a catchment generate notably storm water runoff and are common sources of different pollutants, undeveloped, green surfaces and storm sewers can similarly contribute to polluted runoff within mixed catchments particularly with high nutrients and TSS loads.

Two prerequisites for a sustainable urban development are more pervious, green areas and disconnected or indirectly to the sewer connected runoff surfaces. Modeling mixed urban catchments with significant pervious percentage has been poorly investigated and is getting increasingly significant in estimating pollutant loads for urban water quality assessment particularly in its pervious/impervious dependencies. More research and a better understanding is needed in source contribution of impervious and pervious surfaces as well as the sewer network impact on runoff quality in mixed urban catchments.

The estimation of storm water runoff quality in urban areas has to be carried out more precisely regarding processes connected to infiltration, detention, losses and surface runoff from impervious, developed and pervious, green areas within urban catchments respectively. A study for point source and “end of pipe” estimation of storm water runoff quality has been carried out consisting of both field measurements and modeling. A mixed urban catchment with heterogeneous surface-type distribution (1/3 roofs, 1/3 traffic, 1/3 pervious) has been chosen for both point source and end of pipe measurements. Runoff and rain water quality from different impervious point sources, roofs, roads respectively and the collected runoff quality at the end of the catchment has been measured and modeled independently to estimate model uncertainties regarding pervious surface percentage and sewer contribution to concentration outputs for both TSS and nutrients. Based on uncertainties between measured and modeled values the source based model was complemented by an additional tool for estimating infiltration and surface-runoff from pervious, green areas. Further uncertainties were considered to result from the sewer network and related processes.

Although the model delivered fair concentration outputs, the estimation of runoff quality from both point sources and end of pipe is highly dependent of pervious surfaces and the sewer network. Thus disconnected, partly connected pervious surfaces and storm sewers contribute with a high degree to variation and probable underestimation of pollutant flushes within urban catchments with significant pervious areas.

Retention of nutrients in surface-flow constructed wetlands treating domestic wastewater

Valerijus Gasiūnas

Water Research Institute, Water and Land Management Faculty, Aleksandras Stulginskis University, Parko 6, Vilainiai, LT-58102, Kedainiai district, Lithuania, e-mail: v.gasiunas@water.omnitel.net

Constructed wetlands are considered to be one of the wastewater treatment methods. By construction, they may be designed as surface-flow wetlands. These are wastewater treatment systems in which the processes of pollutants removal occur while wastewater goes through the roots of plants in shallow ponds.

The research was carried out in two wastewater treatment facilities of Lithuanian countryside. With regard to climatic conditions, Lithuania is considered as a country of cold climate. The amount of precipitation is 670 mm, average air temperature is 6.2 ^{o}C. The coldest month is January (-5.1 ^{o}C). Average temperatures are: in winter -4 ^{o}C, in spring 5.5 ^{o}C, in summer 16 ^{o}C, in autumn 7 ^{o}C. In winter period snow cover is 10-20 cm deep, frozen ground can reach 50-70 cm deep.

Wastewater enters the first surface-flow filter after initial treatment in biological ponds, the second filter after treatment in septic tanks. For statistical data analysis 60 samples in different periods of 2003-2010 were taken.

The load with total N in the first surface – flow filter reached 1.3±1.0, in the second one – 13.0±5.0 g m^{-2} d^{-1}. The results indicate that in the filter with lower load the average removal of total N reached 0.116 in winter and 0.20 g m^{-2} d^{-1} in summer time, while statistically significant difference in the higher load filter was not observed with removal of total N reaching 2.4-2.9 g m^{-2} d^{-1}.

After treatment in filters, different forms and amounts of N is observed in water effluent. Increasing concentration of total N in water effluent determines higher amount of NH_4-N. Filter in which total N concentration in effluent reached 24.6 mg l^{-1}, contained 66.3% of ammonia nitrogen, while the second filter with the concentration of 62.0 mg l^{-1} contained 76.8%. This demonstrates that anaerobic conditions dominate in the filters.

The duration of filter operation had an impact on the removal efficiency of total P in the first filter. During the first year of filter operation *Typha latifolia* was planted and vegetation density was low. During that period the same or even greater P concentration was observed in effluent water when compared to influent. The following year the plants proliferated intensively and became dense. However, the efficiency of phosphorus removal increased. The average load of the first filter according to total P was 0.13 g m^{-2} d^{-1} and its removal reached 0.05 g m^{-2} d^{-1}, i.e. estimated removal efficiency was 38.5%. Initial contamination of wastewater in the second filter was higher, therefore, the dependence of phosphorus removal on vegetation density was not observed. The average load of the second filter according to total P was 0.47±0.26 g m^{-2} d^{-1} its removal reached 0.13±0.07 g m^{-2} d^{-1}, i.e. estimated removal efficiency was 27.6%.

As concerns low efficiency of N and P removal, the use of surface – flow constructed wetlands is advisable for additional wastewater treatment from nutrients.

Current and future ice conditions and implications for infrastructure in rivers and lakes

Solomon B. Gebre[1] and Knut T. Alfredsen[2]

Department of Hydraulic and Environmental Engineering, Norwegian University of Science and Technology (NTNU), S.P. Andersens Veg 5, NO-7491 Trondheim, Norway,
e-mail: [1]solomon.gebre@ntnu.no, [2]knut.alfredsen@ntnu.no

Freshwater ice in rivers and lakes plays an important role in the hydrology of rivers in cold regions including Norway. The winter regime of rivers and lakes is characterized by ice formation during late autumn/early winter and final breakup during spring. Ice poses a number of constraints during winter time on infrastructure in rivers and lakes (Prowse et al., 2011) such as river diversions, dams and bridges. On the other hand hydropower operation of regulated plants will influence the natural ice regime through releases of warmer water from reservoirs into the rivers (Jain et al., 1993). In Norway, hydropower has been developed over the entire country as both storage (using lakes and artificial reservoirs) and run-of-river schemes and today it accounts for almost 99% of the electricity production. These generating facilities are impacted on yearly by ice formation and release causing generation losses at a time when demand is at its highest.

This study shows trends in historical data on river and lake ice regimes in Norway and how future climate scenarios influence ice formation in rivers and lakes on a larger (nationwide) scale. Historical data for ice formation and breakup is combined with observation data on climate and discharge to study trends in ice regimes in 25 rivers and lakes distributed across Norway. Results from the analysis of the available ice record do not show a clear overall trend in breakup or freeze-up dates. A serious limitation with the available data is that most observations (particularly river stations) end in the early eighties and thereby miss the period where we see the clearest trends in temperature. To complement this we propose to use the autumn and spring 0^{o}c isotherms to characterize freeze-up and breakup respectively. The isotherm dates can readily be derived from daily temperature data, and this makes forecasts of future ice conditions easier as temperature forecasts for the future are available from climate models.

Further, high spatial resolution (gridded with 1 km^2 resolution) climate scenario data from two GCMs are used to develop scenarios for the length of the future ice season and on the potential for winter thaws which could induce winter ice runs. It has been found that mid-winter thaws will increase in almost the whole of Norway with the exception of few areas in South-Central highlands and in the North-Eastern part of the country. On the other hand, the winter season will get shortened by the delayed onset of the autumn 0^{o}c isotherms and the advance of the spring isotherms. This shows that we may have shorter and milder winter seasons in a future climate but also a more unstable winter with a higher number of freeze-thaw cycles. This may lead to an increase in frequency of mid-winter breakups as well as more frazil production and ice run events that can adversely impact the operation of hydropower facilities.

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Multiple floods impact on engineering structures in river flow

Boriss Gjunsburgs[1] and Saulius Vaikasas[2]

[1]Water Engineering and Technology Department, Riga Technical University, Azenes Str. 16/20, LV-1048, Riga, Latvia, e-mail: gjunsburgs@mail.bf.rtu.lv

[2]Water Management Institute, Lithuanian University of Agriculture, LT-58102, Vilainiai, Kedainiai, Lithuania , e-mail: s.vaikasas@delfi.lt

Water flow in rivers during floods strongly impact transport system infrastructure – roads, bridges, dams, and etc. Frequency and intensity of flood events with high water levels and considerable discharges becomes more frequent and increases the loads on engineering structures in rivers and at the same time the possibility to be damaged. The stability of piers, abutments, guide banks and spur dikes in floods depends on the depth and dimensions of the scour hole at foundations. By preliminary computing scour development in time in multiple floods of different probability, frequency, sequence, and duration, we can estimate possible scour hole depth,width and volume values induced by expected floods. According to calculated scour we can take protection measures if necessary, and reduce the economical and environmental losses.

During multiple floods the scour hole parameters near structures under clear-water conditions are summed up and increases from flood to flood, and each next flood can lead to failure. Contraction of the flow by bridge structures leads to considerable changes in flow pattern, local increase in velocities, and origin of turbulence, eddy and vortex structures. All those changes are the reason of local scour at the abutments, piers, guide banks, spur dikes.

The differential equation of equilibrium for bed sediment movement in clear water was used, and a calculation method for the scour development at the abutment and guide banks during multiple floods was elaborated. According to the method proposed, the hydrograph was divided in time steps, and each step was divided into time intervals. Calculations were performed for each time step of the hydrograph, so that to estimate the influence of the flow unsteadiness during the flood, but in each time step, the flow was assumed to be steady.

According to the tests and the method suggested, the scour starts when the floodplain is flooded and usually stops at the flood peak. The scour development depends on the flow hydraulics, the river-bed parameters, the multiple floods probability, frequency, sequence and duration. At the flood peak, a scour hole is usually formed. Although the scour process can be continued further, it stops, because the flood is time-restricted. The scour time is always less than the flood duration. At the next flood of the same probability, the scour process does not start when the floodplain is flooded, but at a later time step, closer to the flood peak. This happens because of the scour hole developed in the previous flood, which reduces local flow velocity and flow capacity to remove sediments. The duration of the scour process at the second and forthcoming floods is less than at the previous floods. The scour hole depth, width, and volume increase from flood to flood.Method is confirmed by test resulrs.

Proposed methods allows to compute the development of scour depth during expected usual or extreme flood events varying with flood probability, frequency, sequence, and duration at the stage of design or in maintanence period of the river engineering structures. Thus the most dangerous sequence of expected floods for engineering structures can be found in advance, and to take neccesary protection measures.

Ecological recycling agriculture can reduce nitrogen losses – model results from two Finnish catchments

Kirsti Granlund[1], Katri Rankinen[1], Randall Etheridge[2] and Pentti Seuri[3]

[1]Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland, e-mails: kirsti.granlund@ymparisto.fi, katri.rankinen@ymparisto.fi
[2] North Carolina State University, Campus Box 7625
Raleigh, NC 27695, e-mail: jretheri@ncsu.edu
[3]MTT Agrifood Research Finland, Lönnrotinkatu 5, FIN-50100 Mikkeli, Finland, e-mail: pentti.seuri@mtt.fi

Eutrophication is still a major environmental problem in the Baltic Sea. Protection measures are needed to control leaching of excessive nutrients from agricultural areas. Ecological Recycling Agriculture (ERA) is defined as an agriculture system based on local and renewable resources that integrate animal and crop production on each farm or farms in close proximity. As a result, a large part of the nutrient uptake in the fodder is efficiently recycled, resulting in lower nutrient losses (Granstedt et al. 2008).

BERAS Implementation Project aims at promoting ERA agriculture around the Baltic Sea. In Finland, two agricultural catchments have been chosen as case study areas to demonstrate environmental impacts of ERA farming in the BERAS project. INCA-N nitrogen leaching model (Wade et al. 2002) was applied in Lepsämänjoki and Yläneenjoki catchments in order to analyse N cycle and leaching in detail in prevailing and in ERA farming conditions. INCA-N is a catchment scale model that simulates water flow and N transformation and transport in terrestrial and riverine environment. Lepsämänjoki catchment (214 km^2) is a sub-basin of the Vantaanjoki river basin in southern Finland. The river Vantaanjoki discharges to the Gulf of Finland. Fields cover 25% of the area the rest being mainly forest. Main production line in the catchment is intensive crop production. Yläneenjoki catchment (233 km^2) is located in south-western Finland and is one of two major rivers that discharge into Lake Pyhäjärvi. Agricultural land covers 31% of the catchment. Main products are cereals and animals.

A conceptual crop rotation model was developed to represent potential ERA cultivation in the study catchments. The crop rotation was assumed to consist of grasses, cash crop, mixture of cereals and pea, and a fodder cereal (undersown in grass). N fixation and mineralisation were assumed to provide sufficient N for all plants except for fodder cereal which was assumed to recieve manure. Firstly, INCA-N was calibrated in both catchments by introducing present crops and cultivation practices. Secondly, the crop parameters in the model were modified to describe ERA crop rotation and related N fixation and manure application rates. The preliminary model results showed that ERA farming has potential to decrease N losses: the highest peak inorganic stream N concentrations were clearly decreased, compared to concentrations simulated according to present intensive production relying on inorganic fertilizers.

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Wetland restoration in small river catchment: Activities, results and experience

Zenonas Gulbinas

Public Institution Nature Heritage Fund/Lithuanian University of Educational Sciences
A. Juozapavičiaus 9, LT-09311 Vilnius, Lithuania, e-mail: z.gulbinas@gpf.lt

The Dovinė River is the right tributary of the Šešupė River. Its length is 47.0 km and its basin covers a total area of 588.7 km². According to the classification accepted in Lithuania, the Dovinė River belongs to the category of small rivers being a typical flat plain river. The five largest lakes of the Dovinė basin constitute 93.5% of the total lake area: Dusia 2334.2 ha; Žuvintas 934.3 ha; Simnas 243.8 ha, Giluitis 235.1 ha and Amalvas 193.0 ha. The Dusia Lake is the source of Dovinė River, The Dovine flows through the lakes Simnas and Žuvintas while the other lakes are in the basins of the tributaries of the Dovinė River.

During the second half of the twentieth century, the water regime of the Dovinė River and river basin was significantly altered. Many rivulets were channelled, a number of dams were built, and extensive bog and fen areas were drained and meliorated. Sluices-regulators were built in the Dovinė River at the outlets of the Dusia, Simnas and Žuvintas lakes to retain and store part of spring-flood water. In the 80-ties of the last century, the hydrology of the area again was altered due to the execution of large scale amelioration works: a northern and southern part of the Amalva wetland complex were drained, big sections of the Dovinė and Kiaulyčia Rivers canalised, and fish ponds established near the Simnas settlement.

In 2003-2006 the PIN/Matra project "Management and Restoration of Natura 2000 sites through an Integrated River Basin Management Plan of the Dovinė River" (Lithuania), financed by the Netherlands Ministry of Agriculture, Nature and Food Quality, proposed reconstruction of sluice-gates with priority by the following order: 1) The Žuvintas Lake sluice-gates; 2) The Simnas Lake sluice-gates; 3) The Dusia Lake sluice-gates and 4) The Amalvas Lake sluice-gates. Also project proposed the restoration of drained Amalva wetland. Later different planning documents were approved for the Dovine River basin where recommendations and proposals elaborated during PIN/Matra project became as a background for planning decisions.

Nature Heritage Fund (NHF) had prepared technical projects for reconstruction of all four sluice-gates within the project UNDP/GEF project „Conservation of inland wetland biodiversity in Lithuania" (www.wetlands.lt). During the same project Dusia Lake sluice-gate was reconstructed into spillway dam in 2011.

Main planned activities were performed within LIFE+ project "Restoring Hydrology in Amalvas and Žuvintas wetlands" (http://wetlife.gpf.lt/en). Project executor is again Nature Heritage Fund, project started in 2009, the end of the project 2012. During the project the clearcut the southern part of the Amalva raised bog completed; Žuvintas Lake sluice-gate reconstructed into permanent spillway dam and Žuvintas wetland protective dike improved; drainage ditches blocked in ~100 ha of previously clearcut Amalvas wetland area; finished reconstruction of Amalvas sluice-gate into spillway dam ensuring natural water fluctuation and fish migration; the clearcut of other part of Amalva wetland performed and plastic pilling poles used for blocking drainage channels in ~107 ha of Amalva bog; reconstruction of Amalvas polder pumping station finished. This ended the 40 years period of regulation of water level that negatively affected the whole Žuvintas and Amalva wetlands.

Simnas Lake sluice-gate was reconstructed into spillway dam from EU structural funds in 2011. Administration of Žuvintas Biosphere Reserve was the main executor of the project.

Deriving snow cover related model parameters from land surface information

Ulrich Haberl and Hans-Peter Nachtnebel

Institute of Water Management, Hydrology and Hydraulic Engineering, University of Natural Resources and Life Sciences, Vienna, Muthgasse 18, 1190 Wien, e-mail: ulrich.haberl@boku.ac.at, hans_peter.nachtnebel@boku.ac.at

The goal of this work is to improve the estimation of snow cover related parameters from satellite data. Both, spatial snow distribution parameters which are essential for the accumulation period as well as a temperature index based snow melt component of an HBV based model are estimated on the basis of two hypotheses.

Hypothesis I: Snow melt energy can be described by the surface energy balance but usually only limited information about the energy components is available. The temperature index method replaces the energy balance by a semi-empirical relationship utilizing the air temperature data which is available almost everywhere. Remotely sensed land surface temperature of snow-free areas is considered as valuable information to establish an improved energy balance. Assuming that the mean difference between air temperature and land surface temperature exhibits an annual cycle and depends on exposition of the site, the temperature index model can be improved.

Hypothesis II: The most important factors of the spatial variability in snow water equivalent are snowfall distribution and wind induced snowdrift. The latter can be approximated by prevailing wind direction and topography represented by a DEM. A statistical parameter for snow distribution can be derived and applied to the model without calibrating.

Both hypothesis are proved and realized in several catchments in the central Austrian Alps. The mean differences of land surface temperature and air temperature needed for hypothesis I are derived from remote sensing data and air temperature data provided from a meteorological model. Hypothesis I is formulated for clear sky conditions. Due to this fact cloudiness data from a meteorological model have to be integrated in the snow model. Wind direction data used for hypothesis II are also provided by a meteorological model. Comparing the results of simulated runoff and simulated snow cover with observed data, the model with “data based-calibrated” snow parameters according to the presented hypothesis is comparably good or better than the model with manually calibrated snow parameters. Additionally, the approach has the advantage that the number of fitted parameters in the model is reduced.

Frequency analysis of the daily precipitation series on Hurbanovo station (Slovakia) during 1872–2011

Dana Halmova[1], Pavla Pekarova[1], Juraj Olbrimek[2] and Pavol Miklanek[1]

[1] Institute of Hydrology, Slovak Academy of Sciences, Racianska 75, Bratislava, Slovakia, e-mail: halmova@uh.savba.sk
[2] Slovak Technical University, Bratislava, Slovakia, e-mail: olbrimek@stuba.sk

The aim of the paper is to show the multiannual variability of the precipitation on Hurbanovo station in 140-years period 1872–2011. Meteorological observatory Hurbanovo (former Ógyalla) is a representative station for the region of the Danube lowland. The daily precipitation series is processed since 1872 and it was analysed in many studies in last years.

The study is divided into three parts. The first one deals with long-term variability of the annual precipitation totals on Hurbanovo station within the period 1872–2011. The autocorrelation and spectral analysis methods were used (Pekarova, 2003).

In the second part of the study we identified the changes in annual maximum daily precipitation series distribution on Hurbanovo observatory in different periods (70- years periods, for winter-spring and summer-autumn seasons) using histograms, empirical exceedance curves and frequency curves of daily precipitation.

The last aim of the study was the assessment of periods without precipitation longer than 29 days. We calculated the periods of days without precipitation longer than 29 days in the series of daily precipitation in 1872–2011, (Petrovic et al., 2006). The longest period of days without precipitation was 83 days in 1947. The periods without precipitation longer than 29 days occur usually 5-6 times in each decade. Dry periods longer than 50 days occurred 7 times during the 140 years observation. The increased number of forest and field fires in SR correlates very closely with occurrence of the dry periods at Hurbanovo observatory.

Statistical analysis did not confirm neither more frequent occurrence of high daily precipitation (over 51.2 mm per day) nor more frequent occurrence of long dry periods (more than 50 days without precipitation). The decrease of annual precipitation in the period 1942–2011 is due to less frequent occurrence of daily precipitation depths between 0.4 to 25.6 mm.

Keywords precipitation, long-term trends, multiannual variability, spectral analysis

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Ensemble modeling of boundary conditions of flash floods

Péter Hegedüs[1], Szabolcs Czigany[2], Ervin Pirkhoffer[3] and László Balatonyi[4]

[1]Doctoral School of Earth Sciences, University of Pécs, Hungary. H-7624 Pécs, Ifjúság u. 6,
e-mail: hp88@gamma.ttk.pte.hu
[2]Institute of Enviromental Sciences, University of Pécs, Hungary. H-7624 Pécs, Ifjúság u. 6,
e-mail: sczigany@gamma.ttk.pte.hu
[3]Institute of Enviromental Sciences, University of Pécs, Hungary. H-7624 Pécs, Ifjúság u. 6,
e-mail: pirkhoff@gamma.ttk.pte.hu
[4]Doctoral School of Earth Sciences, University of Pécs, Hungary. H-7624 Pécs, Ifjúság u. 6,
e-mail: balatonyi.laszlo@gmail.com

Nowadays, flash floods are one of the most significant natural hazards in Europe and they are responsible for the largest economic losses in Hungary. With the global climate change flash floods appear more frequently. Flash floods are influenced by complex boundary conditions, such as precipitation, relief, soil physics, hydrology, land cover etc. Nevertheless, the main problem can be illustrated by the descriptive term of “too much water in too little time”. To measure and parametrize these runoff-influencing factors, we have established a hydrometeorological monitoring system to collect input data (e.g.: precipitation, soil moisture, water level, and interception) for the hydrologic models in a small forested catchment in SW Hungary.

We tested two runoff models (HEC-HMS and SWMM) to reproduce historic flood events in two pilot catchments in SW Hungary. The main goal of our research is to create and obtain a numeric model based flood forecasting system to predict stream water levels and so possibly flooded areas. Furthermore, it is important to compare the nature of runoff in natural and developed areas, as losses may become more significant in densely populated areas. Such runoff models require a plethora of input parameters, however it is useful to emphasize different conditions during the modeling.

Our results indicate that historic flood events are reproducible by runoff models with sufficient accuracy.

The utilization of organic polymers as coagulant agents in the chemical treatment of non-point source pollution: Case study – Purification of peat derived runoff

Elisangela Heiderscheidt*, Joseph Ngakfumbe, Anna-Kaisa Ronkanen and Bjørn Kløve

Water Resources and Environmental Engineering Laboratory, 90014 University of Oulu, Oulu, Finland, *e-mail: elisangela.heiderscheidt@oulu.fi

The deterioration of surface water quality due to non-point source pollution is a significant issue faced all over the world. In regions such as the boreal zone and the tropics with large peat deposits, the drainage of peatland areas for peat extraction, agriculture and forestry has long been a cause of concern. Peat extraction activities such as drainage and the exposal of peat layers are known to increase the leaching of pollutant substances such as suspended solids (SS), dissolved organic carbon (DOC), metals and nutrients into watercourses located downstream (Kløve, 2001). The leaching of nutrients and suspended matter into sensitive water bodies can cause eutrophication, siltation, loss of biodiversity and other symptoms of water quality deterioration (Heikkinen & Ihme, 1995). Although, in Finland, chemical treatment is considered one of the best available technologies for the purification of peat extraction runoff water, little research has been applied on the development of this treatment method for the purification of non-point source pollution.

Water quality characteristics (temperature, pH, etc.) and process parameters (coagulant type and dosage, etc.) are factors known to influence the efficiency of chemical purification (Gregory and Duan, 2001). Due to their low cost and high efficiency metal salts of iron and aluminium are extensively used in water and wastewater treatment processes. Currently, metal salts of iron are used in several treatment facilities in Finnish peat extraction sites. Nevertheless, variations in runoff water quality and the lack of development of field conditions have led to the application of high coagulant dosages, fluctuations in purification efficiency and high metal concentration in the discharging water.

This study aims to develop the chemical purification of peat derived runoff water via application of organic polymersas coagulants agents. Jar-test experiments have been designed to determine the purification efficiency achieved by low molecular weight, high cationic charged organic polymers. The coagulants performance is evaluated based on the percentage removal of concerning substances such as DOC, SS and nutrients. The influence of water quality parameters such as temperature and pH in the treatment efficiency are also studied.

Overall the purification efficiency achieved was high (90 % tot-P, 92% PO_4-P, 85% SS and 31% TOC). Among tested coagulants poly-DADMAC achieved slightly better removal efficiencies although it required higher dosages (80 mg/l) than polyamine (50 mg/l). The removal of SS was around 20% lower at low temperature (2 ^{o}C). High purification efficiencies were obtained at varying water pH however, up to 40% lower dosages were required for water samples with pH 4.5 than with pH 6.5.

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Effect of down-dwelling ice on lake littoral of Finnish lakes – environmental factors and ecological evidences

Seppo Hellsten, Teemu Ulvi, Mika Visuri and Antton Keto

Finnish Environment Institute, P.O.Box 413, FIN-90014 University of Oulu, Finland, e-mail: Seppo.Hellsten@ymparisto.fi

Ice cover is an essential factor affecting on environmental conditions of the littoral zone of northern lakes. Snow and ice forms a protective hood for littoral and declines the freezing of sediment and biota related to it. On the other hand it acts as a mechanical force both pressing the sediment and eradicating loose sediments and remnants of former vegetation in case of expansion related to fluctuating temperatures during winter.

As a consequence of the descending water level of regulated lakes and reservoirs in winter, the ice presses against the bottom sediment. This ice pressure zone can be divided into two subzones: the frozen ice pressure zone, where the surface of the bottom sediment is frozen, and the non-frozen ice pressure zone, where the descending ice cover just causes mechanical stress and hardening of the bottom without freezing of the surface sediment (Hellsten 1997).

During winters 2002 and 2003 35 different lake shores from northern and southern part of Finland were surveyed and status of surface sediments was observed through drill holes. Empirical relationships between elevation of littoral zone, date and bottom substrate were established to develop a general model predicting the status of surface sediment. Sandy substrate was clearly more sensitive for freezing whereas substrate with higher amount of organic matter remained non-frozen. Water level draw-down during winter expanded significantly the area of frozen littoral and additionally caused obvious effect on littoral biota.

Established simple relationship between the water level drawdown and frozen littoral can be used as an indicator of ecological relevance of lake regulation (Aroviita & Hämäläinen 2008). Ecological effects of frozen littoral was further demonstrated by using distribution of sensitive large sized isoetids such as *Isoetes lacustris* and *Lobelia dortmanna* as an example.

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Flow design of phosphorus filters

Inga Herrmann[1], Amir Jourak[2], Staffan Lundström[2], Annelie Hedström[1] and Maria Viklander[1]

[1]Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology, 97187 Luleå, Sweden, e-mail: inga.herrmann@ltu.se, annelie.hedstrom@ltu.se, maria.viklander@ltu.se

[2]Department of Engineering Sciences and Mathematics, Luleå University of Technology, 97187 Luleå, Sweden, e-mail: amir.jourak@ltu.se, staffan.lundstrom@ltu.se

Agricultural run-off is sometimes treated using sedimentation to reduce the amount of phosphorus (P) entering natural waters. With this technique, primarily particle-bound P is retained. However, agricultural run-off can also contain a substantial amount of dissolved P which is more difficult to remove. It has been suggested to use filters made of materials with high P binding capacity that are also used in wastewater treatment. Such materials can be man-made (e.g. Polonite® and Filtralite P®), natural (e.g. wollastonite and shellsand) or industrial by-products (e.g. slags from steel industry). The retention mechanisms of P in the materials can be adsorption to metals such as Al and Fe or precipitation of calciumphosphates.

To maximize the P uptake by these filters, it is important to optimize their flow regime. Two flow parameters that have been identified to affect the P uptake by the filter material are retention time (Brooks et al. 2000) and hydraulic surface load (Herrmann et al. submitted).

The aim of this study is to investigate which of these parameters is important when designing the filters. Firstly, the effect of hydraulic surface load on P uptake in the filters is investigated. Secondly, the retention time of the water in the filter that is needed for the reaction of P with the material is determined, taking into account the degree of saturation of the material.

The filter material used in this study was Filtralite P®, an expanded clay with natural additives. P solution was made dissolving KH_2PO_4 in distilled water. The effect of three hydraulic surface loads (0.43, 2.80 and 5.16 L m^{-2} d^{-1}) on P binding capacity was investigated in a column experiment. The retention time was determined in a beaker experiment on fresh and pre-used material.

The results of this study will help to improve the function of P filters by clarifying which flow parameter (retention time or hydraulic load) needs to be considered filter design.

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Regulated rivers migratory fish forum

Arto Hirvonen[1], Jukka Muotka[2] and Jaakko Erkinaro[3]

[1]Centre for Economic Development, Transport and the Environment for North Ostrobothnia, P.O. Box 86, FI-90101 Oulu, Finland, e-mail: arto.hirvonen@ely-keskus.fi
[2]Fortum Power and Heat Oy, P.O. Box 100, FI-00048 Fortum, Finland, e-mail: jukka.muotka@fortum.com
[3]Finnish Game and Fisheries Research Institute, P.O. Box 413, FI-90014 Oulu, Finland, e-mail: jaakko.erkinaro@rktl.fi

In May 2010, an unofficial, national Regulated Rivers Migratory Fish Forum for discussion was established in Finland to facilitate integration of interests in hydropower production and safeguarding natural production of migratory fish populations.

The Forum aims at improving information transfer and interaction between regional development projects, hydropower producers, research institutes and both environment and fishery authorities. Assessing potential information needs for research, and further strengthening the societal and practical applicability of scientific information are also prioritized topics on the Forum's agenda. This work also supports the new National Fishpass Strategy, which was launched on March 8, 2012 by the Finnish Government.

Characteristic to the working principles of the Forum is its open nature, reflected especially by the biennial public seminars on timely topics. The Forum convenes 2-4 times a year and nowadays consists of 15 members, representing the four Centres for Economic Development, Transport and the Environment: for North Ostrobothnia, Kainuu, Lapland and Southeast Finland; Finnish Energy Industries and Hydropower companies: Fortum Power and Heat Oy, Kemijoki Oy, Pohjolan Voima Oy, Vattenfall AB; Finnish Game and Fisheries Research Institute; Ministry of Agriculture and Forestry, and Finnish Environment Institute.

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www.ymparisto.fi/ppo/Kalatiet (in Finnish)

Stream flow forecast and operation of Dautieng reservoir for adaption on climate change – a case study in Vietnam

T.H. Hoang[1,2] and K. Miegel [1]

[1]Institute for Environment, Agricultural and Environmental Faculty, Rostock University
Satower Straße 48, 18059, Rostock, Germany, e-mail: huu.hoang@uni-rostock.de,
konrad.miegel@uni-rostock.de
[2]Hanoi Water Resources University, 175 TaySon Str., DongDa Dis, Hanoi, Vietnam

The potential impacts of climate change on stream flow and reservoir operation are investigated in this study for case Dautieng reservoir in Vietnam. A framework is built as an effective methodology to integrate available data on climate change scenarios, the watershed of the reservoir as hydrologic system and reservoir management. This framework includes: (1) generating future climate data by weather generator model for regional downscaling of Global Climate Model (GCM)results from IPCC´s scenarios (IPCC: Intergovernmental Panel on Climate Change), (2) modelling watershed-based hydrologic and reservoir operation on basis of stream flow generation under different climatic scenarios as well as existing reservoir operation rules, (3) investigating various alternative reservoir operating rules to meet future climatic conditions. The results indicate that the effects of different climate change scenarios on reservoir management will be probably significant and require adaptive operating rules for the future.

Development of catchment scale inorganic N loading model WSFS-VEMALA-N

Inese Huttunen[1], Markus Huttunen[1], Bertel Vehviläinen[1] and Ahti Lepistö[1]

[1]Freshwater Centre, Finnish Environment Institute, P.O. Box140, FIN-00251 Helsinki, Finland, e-mail: inese.huttunen@ymparisto.fi

The WSFS-VEMALA model simulates hydrology and water quality for all river basins in Finland. The simulated water quality parameters are total phosphorus, total nitrogen and suspended solids. The model simulates on daily time step nutrient leaching from terrestrial areas, nutrient load balance for each lake, nutrient transport in rivers and finally loading into the Sea. Nutrient diffuse loading simulation was based on the daily relationship between nutrient concentration and the daily runoff, where the main dynamically changing variable is runoff and time independent parameters are calibrated for each sub-catchment, for each land use class and for each season of the year. We are developing a new conceptual catchment scale inorganic N model (VEMALA-N) in order to replace or compare old simplified approach with more process based one. WSFS-VEMALA consists of three main parts – nutrient leaching from terrestrial part, nutrient processes in the rivers and nutrient balance for the lakes.

Sub-model of inorganic N leaching from terrestrial part is applied for five land use/ crop classes – spring cereals, winter cereals, grassland, root crops and forest. The daily fluctuations of main soil N processes are simulated for each class. Main soil N processes included in the model are mineralization, nitrification, denitrification, immobilization, plant uptake, fertilizer decay and N leaching. Most of the processes are first order rate processes depending on Nitrogen species storage, soil temperature coefficient and soil moisture coefficient. Plant uptake is simulated in conceptual way based on relationship between biomass growth and growth day degree index (GDD), actual N plant uptake is corrected by water stress depending on soil moisture deficit. Mass balance of Nitrate and Ammonium in the soil is calculated for each time step and subsequently, soil water concentration of Nitrate is calculated depending on Nitrate mass and soil water content in soil. Nitrate leaching is then simulated depending on subsurface flow volume and soil water concentration of Nitrate. Nitrate leaching with groundwater flow is simulated as well, depending on groundwater flow volume and calibrated groundwater flow Nitrate concentration.

So far VEMALA-N model has been applied to 27 agricultural river catchments in South-West and Southern part of Finland to estimate inorganic N loading to the Baltic Sea. The simulated Nitrate concentration and load results for several representative river catchments (at two sites in each catchment) will be discussed. Suttcliffe and Nash coefficient R^2 for simulated Nitrate loads for Aurajoki and Vantaanjoki rivers varies in range 0.61 – 0.79, R^2 for simulated Nitrate concentrations for Aurajoki and Vantaanjoki rivers are much lower and varies in range 0.1 – 0.34. It is questionable is Suttcliffe and Nash coefficient R^2 representative efficiency criteria also in water quality models. Model results are analyzed for small agricultural catchment sites (Savijoki, 15 km^2 and Lepsämänjoki, 213 km^2) and for bigger streams at river downstream parts (Aurajoki, 730 km^2 and Vantaanjoki, 1600 km^2). Model simulates quite similar concentration pattern at the headwaters sites and downstream sites, however observed concentration patterns are different. Most probably that can be explained by two reasons – (1) river processes in the streams are not well enough represented, (2) spatial variation of inorganic N processes is not well enough captured by model. Those are the directions of further development.

Problems in Atlantic salmon smolt passage downstream the heavily regulated rivers in the northern Baltic Sea

Riina Huusko, Panu Orell, Aki Mäki-Petäys, Peter Rivinoja, Jaakko Erkinaro and Mikko Jaukkuri

Finnish Game and Fisheries Research Institute, P.O. Box 413, FI-90014 Oulu, Finland, e-mail: riina.huusko@rktl.fi

Re-establishing wild Atlantic salmon stocks in regulated rivers requires functioning migratory routes. The migrations of adult ascending fish are usually arranged by fishways, but downstream migrating smolts are normally forced to swim trough turbines, which may cause significant mortality and migration delays. Survival and migration behavior of radio-tagged Atlantic salmon smolts were studied in the regulated rivers Oulujoki and Iijoki in 2009-2011 to find potential migration problems.

The overall survival of radio-tagged salmon smolts through multiple power plants was found extremely low (< 3%) in both river systems. In general, smolts accumulated above power plants and significant migration delays were observed. Direct turbine mortality was found reasonably low (0-17%), but the motivation of smolts to swim trough turbines decreased after passing the first power plant. Turbine intake depth seemed to affect migration delay and smolt passage rate: deeper intake increased migration delay and decreased passage rate.

Overall, restoration of regulated rivers salmon populations is highly dependent on securing the downstream migration of smolts. Smolt guiding devices may be needed for fast and successful by-pass of smolts at power plants.

Phosphorus leaching from different peatland uses during rewetting for future catchment restoration

Maarit Hyvärinen[1], Pirkko Mustamo[1], Anna-Kaisa Ronkanen[1] and Bjørn Kløve[1]

[1]Water Resources and Environmental Engineering Laboratory, University of Oulu, P.O. Box 4300, FIN-90014 Oulun yliopisto, Finland, e-mail: maarit.hyvarinen@oulu.fi

Peatlands have important role controlling the water quality to lower water bodies, because they can act as a sink for nutrients. However, due to drainage and different land uses such as agriculture, forestry and peat extraction, most of the sites have lost this function. Restoration of peatlands by rewetting aims to restore ecological and hydrological functions, to re-establish nutrient and water retention capacity, to improve biodiversity and to reduce greenhouse gas emissions, especially from abandoned agricultural fields when cultivation is no longer possible.

Elevated water table during restoration results in changes in geochemistry of peat soil. Reductive dissolution of Fe^{3+} and release of sorbed phosphorus during rewetting is a major threat when drained peatlands are restored, especially in those peatlands which have been previously intensively cultivated. Phosphorus is often the limiting nutrient in freshwater ecosystems, therefore leaching can cause eutrophication in down-stream watercourses. Thus more information is needed for restoration management to avoid harmful impacts on water quality.

The objective of this study is to investigate potential for phosphorus leaching from peat soils with different land uses under changing hydrological conditions. The aim is to study release of phosphorus to porewater and surface water from peat soils in flooding conditions.

The experiments are conducted by studying intact peat cores in laboratory. Peat cores (0-30 cm) were taken from peatlands with different land uses (cultivated site, peatland forest, peat extraction site and pristine bog) with three repetitions. The cores are flooded and water samples are collected from pore water and surface water for dissolved P analysis.

The experiments are still ongoing, but there is evidence from release of P. According to the preliminary tests leaching from the cultivated peat soil is high in anaerobic conditions; at the end of the test (after 84 days) 20 mg P kg^{-1} soil was leached to the water phase. Leaching of phosphorus was clearly lower in the peat extraction site; below 1 mg P kg^{-1} soil was leached after 42 days. Based on the results, the land use history of the area must be considered carefully when rewetting of the site is planned.

Snow water monitoring with stationary radar

Pekka Hänninen[1], Juha Majaniemi[1] and Raimo Sutinen[2]

[1]Geological Survey of Finland, Betonimiehenkuja 4, FIN-02150 Espoo, Finland, e-mail: juha.majaniemi@gtk.fi, pekka.hanninen@gtk.fi
[2]Geological Survey of Finland, P.O. Box 77, FIN-96101 Rovaniemi, Finland, e-mail: raimo.sutinen@gtk.fi

In the boreal climate snowmelt is one of the most important events for the recharge of ground water reserves, initiation of spring recovery of forests as well as being a key factor contributing to floods within the river watersheds. Snow water (snow water equivalent) provides important information for prediction of these events, yet snow thickness and density commonly is still measured manually. In the present study we applied ground penetrating radar (GPR; Model SIR-3000 by GSSI) to monitor snow and soil water content through measurements of the elapsed ground pulse time and of the change in amplitude of the returned radar signal with one GHz antenna (by GSSI) mounted at stationary position above the ground.

Our GPR design was to apply a constant distance (d=1.3 m) between the antenna and the ground surface, hence the change in dielectric is due to replacement of air (ε_a=1) with snow that is a dielectric mixture of air and ice (ε_i=3.2) (Bogorodsky et al. 1983). Since the measuring distance is constant a change in the travel time of ground pulse allows us to determine snow water content. An automatic soil monitoring station (w. Capbell logger with CS616 sensors; see Sutinen et al. 2008) was established as reference for the ground pulse amplitude measurements, i.e. GPR monitoring of surface soil water content. The experiment was run from mid-September 2010 through May 2011.

We found that the amplitude of the ground pulse was proportional to the changes in soil water. However, accurate information of soil water content requires (e.g. the Campbell CS616) calibrations. This was particularly true for non-frozen ground in the fall as well as beneath dry pendular snow (e.g. Denoth 1999). In cases, when the snowless ground surface freezed, e.g. in late October, the ground pulse amplitude failed to measure soil water. This is because of the phase change from (surface) water (ε_w=81) into ice (ε_i=3.2). Also, in late spring (from April 2011) the amplitude of ground pulse, due to reversal dielectric contrast (i.e. high vs. low) between wet funicular snow (see Denoth 1999) and soil dielectric properties (see Sutinen et al. 2008). During the late winter period, from January through late March, there was a good linear relationship between the travel time of ground pulse and (pendular) snow water content (mm/m^2). The observed relationship was not feasible for the period from the beginning of April (the melt of funicular snow) through the mid-April (snow disappearance). Our results indicated that pendular snow water can be predicted with measurements of ground pulse travel time of 1GHz-GPR. In addition, changes in the soil water content can be monitored through the amplitude changes of the GPR ground pulse.

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Impact of hydrological mire restoration on spring invertebrate communities

Jari Ilmonen[1], Risto Virtanen[2], Lauri Paasivirta[3] and Timo Muotka[4]

[1]Metsähallitus, Natural Heritage Services, P.O. Box 94, FI-01301 Vantaa, Finland, email: jari.ilmonen@metsa.fi
[2]University of Oulu, Department of Biology, P.O. Box 3000, FI-90014 Oulun yliopisto, Finland, e-mail: risto.virtanen@oulu.fi
[3]Ruuhikoskenkatu 17 B 5, FI- 24240 Salo, Finland, email: lauri.paasivirta@suomi24.fi
[4]University of Oulu, Department of Biology, P.O. Box 3000 FI-90014 Oulun yliopisto, Finland, and Finnish Environment Institute, Natural Environment Centre, Finland, e-mail: timo.muotka@oulu.fi

We assessed how hydrological restoration of a mire influenced benthic macroinvertebrates in associated freshwater springs. The mire is fed by moderately calcium-rich groundwater and hosts many vascular plant and bryophyte species with high conservation value. The mire was ditched in 1970 and restored 2001-2002, primarily aiming at restoring the habitats for the vegetation.

Responses of vegetation was monitored along four transects across the mire and invertebrates in springs variably affected by restoration measures on the restored mire, and in remote control springs. We collected pre-restoration invertebrate samples in May 2001 and post-restoration samples in May 2003, 2005 and 2010.

Following restoration of the mire hydrology, water table rose in the whole mire, including springs. Mire vegetation has generally benefited from the restoration, although all parts of the mire were not re-wetted as much as desired. Restoration also caused profound changes to groundwater quality but, for the most part, water quality returned close to pre-restoration condition within two years. Reflecting these chemical and hydrological changes, restoration altered spring invertebrate communities, especially relative abundances of species. While the proportional abundance of spring-dependent (crenophilous) macroinvertebrates remained relatively stable in the remote control sites, their proportion decreased strongly in both impacted and control springs in the restoration area.

Macroinvertebrate community structure at the remote control sites remained almost unchanged throughout the study, whereas communities in both control and impacted sites in the restoration area showed profound changes after the restoration, followed by a slight trend towards the initial conditions by 2010. Restoration may thus have undesired long-lasting effects across hydrologically connected habitats.

Impacts of climate variability and change on snow accumulation and melt in Kajaani, Finland

Masoud Irannezhad[1], Anna-Kaisa Ronkanen[1] and Björn Klöve[1]

[1]Water Resources and Environmental Engineering Laboratory, University of Oulu, P.O. Box 7300, FIN-90014 Oulun yliopisto, Finland, e-mail: masoud.irannezhad@oulu.fi

This paper evaluates changes in snow water equivalent and snowpack peak outflow caused by climate variability and change in Kajaani for the period 1903-2008. Observed daily precipitation, temperature and the snow water equivalent data from 1946 to 2008 were used to calibrate and validate the empirical snowmelt temperature-index model. Climate variability was described by changes in annual precipitation and mean temperature anomalies. Mann-Kendall non-parametric test and Fourier series method were used to determine any trend or cyclic pattern in the annual anomalies. The results showed that the annual precipitation decreased by 0.77 mm per year at the 5% significant level, while there was no clear trend in the annual mean temperature. The annual precipitation and mean temperature anomalies indicated that time cycles of wet-dry and warm-cold regimes are about 20 and 69 years, respectively. The SWE decreased by 0.51 mm per year at the same significant level, although the time cycle of 135 years was estimated for a high-low SWE regime. A linear relationship between snowpack meltout and the temperature was found after 8.30°C. Comparing 1 to 10-day(s) peak outflow during a hydrologic year indicated the meltout influenced the peak outflow much more than rainfall, and the 10-days peak outflow could be used to describe high peak outflow years. The 10-days peak outflow decreased by 0.31 mm per year, whereas the time cycle of its high-low mode was estimated to 102 years. The results determined the climate variability and change in Kajaani caused decreases in the snow accumulation and snowpack peak outflow from 1903 to 2008.

Impacts of changes in winter period temperature on snowpack water availability: a case study from Southern Finland

Masoud Irannezhad[1], Anna-Kaisa Ronkanen[1] and Björn Klöve[1]

[1]Water Resources and Environmental Engineering Laboratory, University of Oulu, P.O. Box 7300, FIN-90014 Oulun yliopisto, Finland, e-mail: masoud.irannezhad@oulu.fi

Variations in temperature of winter period directly affect water content of snowpack due to shifting of precipitation falling form from snow to rain or vice versa. Using temperature and precipitation data with combination of the temperature-index model of snowmelt, we evaluated changes in snowpack water availability in southern Finland. The model was calibrated and validated according to observed precipitation, temperature and snow water equivalent data from 1946 to 2011. Trend analyses at the 5% of significant level by Mann-Kendall non-parametric test determined that the mean temperature increased (by 0.01 °C/year), and the precipitation decreased (by 1.00 mm/year) during the winter periods from 1858-2011 for the Kaisaniemi FMI weather data. A decreasing trend in number of days with negative temperature (by 0.24 day/year) and decreases in average value of all negative mean temperatures (by 0.006 °C/year) occurred during the winter periods of whole period of study. These decreasing trends resulted in less frequent snowy days (by 0.12 day/year) and reduction of snowfall amounts (by -1.08 mm/year). The number of rainy days increased (by 0.055 day/year), while there were not any clear trends in rainfall, number of days with positive mean temperature and average value of all positive temperatures in the winter period. The snowpack water availability during the winter time showed a decreasing trend by 1.26 mm per year. It can be concluded that the decreases in the water content of snowpack in Southern Finland caused by increases in the temperature of winter period that decreased the snowfall and increased frequent rainfall events.

Arsenic cycling in catchments with sulphidic metasediments, N. Sweden

Gunnar Jacks[1], Magnus Mörth[2], Zdenka Slejkovec[3] and Elin Nilsson[4]

[1]Dept.of Land & Water Resources Engineering, KTH, SE-10044 Stockholm, Sweden, e-mail: gunnjack@kth.se
[2]Dept of Geology & Geochemistry, Stockholm University, SE-11691 Stockholm, Sweden e-mail: magnus.morth@geo.su.se
[3]Jozef Stefan Inst., SL-1000 Ljubljana, Slovenia, e-mail: zdenka.slejkovec@ijs.sl
[4]Norsjö Community, SE-93581 Norsjö, Sweden, e-mail: elin.nilsson@mala.se

The Västerbotten county is underlain by about 4 000 km^2 of black sulphidic metasediments. The metasediments contain 0,5-1 % S mostly in the form of pyrite with minor amounts of arsenopyrite and sphalerite. The metasediments are mixed into to till. At weathering the sulphides are oxidized releasing metals, among them a pronounced amount of arsenic. The arsenic is adsorbed in the B-horizons of the podzolic soils (Gustafsson and Jacks, 1995). In wetlands with reducing conditions iron and arsenic is remobilised but when the groundwater discharges into ditches and streams, iron is precipitated as ferric hydroxides and most of the arsenic readsorbed onto these precipitates. Sandy sediments may contain up to 500 mg/kg while ferric precipitates may contain up to 0,5 % As. Elevated amount of zinc is also found both in the surface water and in stream sediments. Lakes in sulphidic metasediment areas show elevated arsenic content up to 20 μg/l. Separation of the arsenic and other metals in particle and molecular sizes reveals that most of the arsenic is found in the particulate and colloidal matter and likely to have low bioavailability. Speciation of arsenic into As(V) and As(III) is difficult in surface water and the results are doubtful but it would be reasonable that the bulk is As(V) and then adsorbed onto ferric particles and colloids (Sracek et al., 2003).

Land use has pronounced effects on the metal transfer. Forest drainage has been intense in periods with subsidies. As much as 400 km length of drainage ditches has been found in an area of 36 km^2 (Miskovsky et al., 2012). This has increased notably zinc transport while most of the arsenic has found a sink in the ditches and streams. When the ditches are gradually obstructed by the growth of mosses raising the groundwater level, arsenic and iron is remobilised.

The aim has been to assess the environmental risk of arsenic cycling in the metasediment areas. One risk considered is exposure of arsenic to grazing and browsing wild animals. Only *Equisetum spp* are found to have elevated contents of arsenic. These species comprise a small fraction of the intake of mooses, less than 10 % and should not be a considerable risk. Another risk taken into evaluation is the accumulation of arsenic in fish. Neither has this been found to be very serious. Most of the arsenic in fish is in organic form as MMA, DMA and arsenobetaine with a low toxicity. The low bioavailability of arsenic in surface water is likely to be due to the arsenic association with ferric precipitates. Moreover, detoxification of the arsenic, conversion to organic species in macroinvertebrates and fish. may be contributing.

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Comparison of SMOS-satellite soil moisture observations with HBV-model simulations in Aurajoki watershed, Finland

Juho Jakkila[1], Tiia Vento[1], Tapani Rousi[1] and Bertel Vehviläinen[1]

[1]Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland,
e-mail: juho.jakkila@ymparisto.fi

SMOS level 2 soil moisture observations were compared to soil moisture simulations of Watershed Simulation and Forecasting System (WSFS). The observations have been obtained since June 2010 and the validation period includes years 2010-2011. Due to low penetration depth of the satellite observations, the HBV-based model in WSFS was developed to simulate soil moisture in two layers: 10 cm thick surface layer and 80 cm thick sub-layer. The sub-basins of the 2-layer model were divided into six classes of soil types: sand, silt, clay, organic material, till and rock to characterize the soil properties of the catchment area. The soil parameters of different soil types were calibrated using TDR-observations from soil moisture stations and the other parameters of the model against discharge observations. The 2-layer model was found effective in reproducing observed discharges in the test area, River Aurajoki, located in Southwest Finland. The simulations of the soil moisture content in the surface layer show similar behaviour with the SMOS-observations, though the level 2 data still produces rather low values in the area largely covered by clayey soils. However, the data of the year 2010 gives a promising result, that the satellite observations could be used as an indicator of the filling of the soil moisture storage in the WSFS after a long dry period.

Improving the ecological state of a large harnessed river – a case study of the River Oulujoki, Finland

Riitta Kamula[1] and Simo Tammela[2, 3]

[1]Instructional Coordinator, Thule Institute, University of Oulu, Finland, e-mail: riitta.kamula@oulu.fi
[2]Water and Environmental Engineering Laboratory, University of Oulu, Finland,
[3]Insinööritoimisto Ponvia Oy, Finland

Most of the waterpower facilities in Finland have been constructed in the 1950's and 1960's. Implementation of power plants proceeded on the basis of technical and economic calculations, while environmental and social impacts were given minor or no attention.

The River Oulujoki used to be a famous salmon river before it was harnessed for water power production in the 1940's and 1950's. The power plants hindered fish migration into the river and fish populations were maintained by fish stockings. In 2003, after fifty years of blockage, the Merikoski dam at the river mouth got a new well-functioning fishway.

In 2006-2007, a feasibility study to equip with fishways the next dams below the Lake Oulujärvi was carried out. Based on the study, a large project to improve the ecological state of the River Oulujoki started in 2008: The project included fish stockings, habitat restorations, construction of spawning channels, and follow-up as well as administrative measures, but also detailed planning of fishways to six dams. Quite soon it was recognized that the focus in fishways planning should be in the Montta fishway, not just because it is the lowest obstacle but also because of the demanding conditions for fish migration below the dam. Montta also proved out to be the best place to include habitat channel or section in the fishway. Montta was also set as a model fishway and the approaches created for the Montta fishway were applied to other fishways in the River Oulujoki.

This paper describes the planning process to improve the ecological state of the River Oulujoki in Finland. The paper discusses the economical, societal, biological, and juridical challenges and ways the different requirements have been met in this project. Main focus is on the planning process of fishways, especially in the connection with the Montta hydropower plant.

Keywords: fish migration, fishway, planning, attraction, entrance, water power, WFD

An interactive decision analysis framework for the support of groundwater management – a case study of a Finnish esker

Timo P. Karjalainen[1], Pekka M. Rossi[2], Pertti Ala-aho[2], Riku Eskelinen[2], Kalle Reinikainen[3] and Bjørn Kløve[2]

[1]Thule Institute, University of Oulu, P.O. Box 7300, FIN-90014 University of Oulu, Finland, e-mail: timo.p.karjalainen@oulu.fi
[2] University of Oulu, Water Resources and Environmental Engineering Laboratory, P.O. Box 4300, FIN-90014 University of Oulu, Finland, e-mail: pekka.rossi@oulu.fi, pertti.ala-aho@oulu.fi, reskeline@paju.oulu.fi, bjorn.klove@oulu.fi
[3]Pöyry Finland Oy, Tutkijantie 2 A-D, FIN-90590 Oulu, Finland, e-mail: kalle.reinikainen@poyry.com

Multi-criteria decision analysis (MCDA) methods are increasingly used to facilitate both rigorous analysis and stakeholder involvement in environmental and water use planning in general. However, these methods have not been used in groundwater management. This study contributes to groundwater resource management by providing one of the first examples of the decision analysis approach to aid deliberation and to form sustainable land-use management alternatives. Emphasis is placed on the interactive and integrated role of the MCDA tool in a process to facilitate systematic assessment, transparency and stakeholder participation. The applied decision analysis interview approach, in the case of a Finnish esker aquifer, enhanced capabilities towards collaboration and social learning in a process where disputes and a diversity of interests were represented. Computer-aided interviews (N=17) helped participants' to see how their preferences affected the desirability and ranking of alternatives. During the process participants' knowledge and preferences evolved as they could assess their initial knowledge of new scientific information. The decision analysis process led to the opening of dialogue and negotiation, showing the overall picture of the problem context, different viewpoints of stakeholders and critical issues for the further process.

Heat convection in water percolating in soil

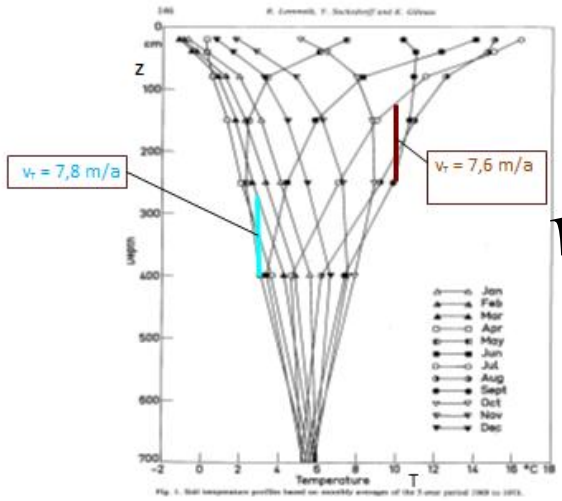
Servo Kasi

Aalto University, Finland, e-mail: servo.kasi@Aalto.fi

Temperature distributions in the 7 meter soil layer was published by Lemmelä et al. (1981). They found that the trigonometric presentation

$$T(z) = \sum_{n=0}^{2} A_n(z)\ \sin(2\pi n\ t/a + \phi_n(z))$$

was applicable (the 3rd and 4th terms do not improved the presentation).



$$v_T = \left(\frac{\partial z}{\partial t}\right)_T$$

The partial derivatives v_T above present the spring (the cold) and autumn (warm) temperature flows. The infiltrated water convects the heat (and cold). From water the heat (and the cold) conducts to soil.

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Comparison of two- and three-dimensional morphodynamic models in a natural sandy-bed river bend.

Elina Kasvi[1] and Eliisa Lotsari[1]

[1]University of Turku, Department of geography and geology, FI-20014 Turun yliopisto, Finland, e-mail: emkasv@utu.fi

The increased computational efficiency enables applying 3-dimensional (3-D) computational fluid dynamics (CFD) with higher spatial resolution and to larger areas than before. Previous studies have shown that 3-D CFD simulate the flow structure more accurately than 2-D models. This is evident especially in curved channels, where the flow is highly 3-dimensional in nature and the flow structure affects the changes in river morphology. A morphodynamic component enables the model to modify the river geometry as a response to the flow field and morphological features of the channel on each time step. Thus, completing the CFD with morphodynamic component increases the applicability of simulations further and usage of morphodynamic models have increased widely recently. However, the 3-D models still require more field measurements and computing time compared to 1-D and 2-D models.

In this study, we apply two- and three-dimensional morphodynamic models to one river bend with highly mobile bed. We use high-resolution field measurements to build the river geometry for the model and we model the morphological changes over four months. A spring flood occurred in the beginning of the simulation period and the discharge was bank-full. We compare the results of 2-D and 3-D morphodynamic simulations with the field measurements. We specify parts of the bend, where the differences of the two models are emphasized and we discuss the impact of various factors in the simulation results. As a conclusion, we give directions about in which kind of applications the 3-D model is preferred or required to predict the changes in river morphology and how the computational efficiency and minimal field investigations meet the acceptable modelling accuracy in curved channel.

Drought and aridity challenge in arid and semi arid climates due to land and water use pressures

Pouyan Keshtkaran[1], Ali Torabi Haghighi[2] and Bjørn Kløve[3]

[1]Department of Civil Engineering, Estahban Branch, Islamic Azad University, Estahban, Iran, e-mail: P_keshtkaran@iauestahban.ac.ir
[2]Water Resources and Environmental Engineering Laboratory, University of Oulu, Oulu, e-mail: Ali.Torabihaghighi@oulu.fi
[3]Water Resources and Environmental Engineering Laboratory, University of Oulu, Oulu, e-mail: bjorn.klove@oulu.fi

Drought is a major natural hazard disaster that covers vast areas such as countries, regions or even a continent while other disasters such as earthquake and flood have point or linear effect. Hydrological drought depends on climate and is a periodical phenomenon with a certain return period and possibility of occurrence. Aridity is a geographical characteristic which can mostly be observed in arid and semi arid regions. Agricultural drought has harmful consequences in arid and semi arid regions of the developing world when people's incomes to large extent depend on agricultural. Most arid and semi arid regions with shortage of surface water, have developed ground water extraction to cover demands in agriculture, urban development, industry. Large amount of groundwater can be pumped at fairly low cost during this phase of development that could be called Golden Devloping Age (GDA). In many regions groundwater is pumped more than the formation and after a transition time depending on aquifer characteristics and recharge the water extraction cost increases and water quality decreases dramatically. The people's level of expectation from ground water resources has reached the level they had during GDA period but the ground water resources cannot meet all demands and based on this condition and expectation, the frequency of drought changes from a periodic phenomenon to a permanent phenomenon. The ground water resources can not come back to GDA period because of the aridity as the main characteristic of arid and semi arid regions. As a result, other physical and social problem such as ground settlement, appearance of cracks in ground surface, spring dryness, abandoned villages, and so on will occur in these regions. Fars province with 123000 km^2 area is one of the largest provinces in south west of Iran. This province has variety of climate which is warm and dry in southern and eastern parts and cold in northern parts. Difference in temperature from -10 ºC to 45 ºC in different parts of this province and different annual amount of rainfall from 100mm to 800mm are specific climotological characters of this province. Fars province is an agricultural pole in Iran and considering the huge amount of water extraction from ground water resources, the level of underground water tables in most plains of the region has a negative balance. In recent years, more than 15 years of droughts with different intensities have occurred in different parts of Fars province. As a result of the drought and high amount of water consumption, the water levels in 104 plains of Fars under study have decreased from 5 to 21 meters. In this research we use the SPI (standard precipitation index) and climatological methods, to assess the border between drought as a periodical climate condition and aridity as geographical characteristic of arid region.

Analysis of nutrients' point sources of pollution in the lowland river catchment and river self-purification potential in river continuum

*Edyta Kiedrzyńska[1,2], Magdalena Urbaniak[1,2], Marcin Kiedrzyński[3] and Maciej Zalewski[1,2]

[1] International Institute of Polish Academy of Sciences, European Regional Centre for Ecohydrology under the auspices of UNESCO, 3 Tylna Str., 90-364 Lodz, Poland,
*e-mail: edytkied@biol.uni.lodz.pl
[2] University of Lodz, Department of Applied Ecology, 12/16 Banacha Str., 90237 Lodz, Poland.
[3] University of Lodz, Department of Geobotany and Plant Ecology, 12/16 Banacha Str., 90237 Lodz, Poland

Eutrophication is a major problem in the Baltic Sea, caused by the inflow of large loads of nutrients. Waterborne inputs to the Baltic Sea in 2006 amounted to 638,000 tonnes (t) of nitrogen (N) and 28,400 t of phosphorus (P). Poland discharged the highest load of phosphorus (36%, 10,224 t P) and nitrogen (24%, 153,120 t N) from among all the countries of the Baltic Sea basin (Knuuttila, 2011). This is largely due to point sources of pollution such as sewage treatment plants (STPs), that discharge poorly treated wastewater into rivers.

This study presents an ecohydrological approach to analysis of point source pollution (red-points) in the lowland river catchment and the potential of river to self-purification in the river continuum. The research was carried out in the Pilica River catchment having the area of 9 258 km^2, located in central Poland. The Pilica River (length: 342 km) is the biggest left-bank tributary of the Vistula River – the biggest river of Poland. The main goals of the research were: 1) evaluation of the role played by the STPs in eutrophication of the Pilica River, and 2) quantification of nutrients transfer along the Pilica River continuum and its self-purification.

Samples were collected from the outlets of 17 STPs, that were divided into three categories of size: I class: 0 – 1 999; II class: 2 000 – 9 999, IV class: 15 000 – 99 999 of population equivalent. The riverine samples were collected twice during the spring (high water level) and summer period (low water level) of 2010. The samples were taken from 6 stations located along the Pilica River continuum, from the source to the outlet to the Vistula River.

The results have shown that the highest average concentrations of total phosphorus (TP 5.12 mg dm^{-3}) and total nitrogen (TN 92.1 mg dm^{-3}) were in the wastewater outflow from the smallest (I class) STPs, showing the problem of maintaining good treatment parameters. The larger STPs have lower concentrations of TP and TN in the wastewater (II class – 3.68 mg TP dm^{-3} and 55.9 mg TN dm^{-3}, and for IV class – 3.05 mg TP dm^{-3} and 58.7 mg TN dm^{-3}), which indicates more advanced wastewater treatment technologies. The study have also demonstrated the increase of the TP concentration along the Pilica River continuum (from 0.66 mg TP dm^{-3} to 1.15 mg TP dm^{-3}). This was caused by the gradual inflow of nutrients along the river continuum, mainly with domestic and industrial wastewater, however in the sections in between inflow sites the decrease of nutrients concentration was observed.

The research was supported by the Polish Ministry of Science and Higher Education, Project: N N305 365738 "Analysis of point sources pollution of nutrients, dioxins and dioxin-like compounds in the Pilica River catchment and draw up of reclamation methods".

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Impact of historical and current land use on vegetation of urban river valley in a perspective of its rehabilitation plan

Marcin Kiedrzyński[1,*], Edyta Kiedrzyńska[2, 3], Piotr Witosławski[1] and Józef K. Kurowski[1]

[1]Department of Geobotany and Plant Ecology, University of Lodz, 12/16 Banacha Str., 90-237 Lodz, Poland, *e-mail: kiedmar@biol.uni.lodz.pl
[2]International Institute of Polish Academy of Sciences, European Regional Centre for Ecohydrology under the auspices of UNESCO, 3 Tylna Str., 90-364 Lodz, Poland
[3]Department of Applied Ecology, University of Lodz, 12/16 Banacha Str., 90-237 Lodz, Poland

The ecological evaluation of the Sokołówka River valley, located in the city of Łódź, Poland, was conducted to assist in the design of the scientific approach needed to improve both the state of the environment and the quality of life. This research was supported by the SWITCH (Sustainable Water Management Improves Tomorrow Cities Health) project, financed by the European Commission.

The landscape most serious modifications took place in the area of Łódź in the 19th century during the development of textile industry. The Sokołówka River valley was mainly affected by the 20th century changes, resulting from progressive urbanization (Witosławski, 2006). Although its upper section is strongly modified and the river is trained, some small natural fragments survived.

The aim of this study was to analyze the impact of changes in land use in last 200 years on the actual vegetation in Sokołówka Rriver valley. The historical changes in land use were identified on the basis of archival topographic maps. Actual real vegetation in the ecotone buffer zones, i.e. the not build-up areas was mapped by topographical methods, with a scale of 1:5000 and based on ortophotomaps. In some cases the precise location of the border of phytocoenoses was determined by a GPS receiver. Vegetation units were defined as uniform phytocoenoses with regard to their phytosociological character, naturalness and succession stage. Maps were drawn and analysed using a GIS cartographic package, ArcGIS 9.2. ESRI.

The spatial analysis shown that the eastern part of the study area has been transformed far more than the western part and we include it to the “city centre”. It is dominated by anthropogenic vegetation forms. In the past, this part of the valley, especially certain parts of the floodplain, was used as a dumping site and actually has ruderal plant communities. The western part of the study area is characterized by more natural vegetation and is considered to be in the “outskirts” of the city. In this part fragments of alder forest have been preserved.

As far as ecosystem restoration policies are concerned the two sections of the Sokołówka river valley should be given different priorities. According to Hulse and Gregory’s (2004) concept, the “outskirts” have high ecological potential with low demographic and economic constraints and the “city centre” has low ecological potential with high demographic and economic constraints. The Sokołówka River valley is one of the protected areas in Łódź. Compliance with the rules of use and protection of the most valuable sites should be one of the restoration-related goals.

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Modeling Toxic Metal Remediation Capacity in Bioretention Cells

Nils-Otto Kitterød[1], Kim Aleksander Haukeland Paus[2] and Bertil Nistad[3]

[1]Norwegian University of Life Science, Department of Plant and Environmental Sciences, P.O.Box 5003, N-1432 Ås, Norway, e-mail: nils-otto.kitterod@umb.no
[2]Norwegian University of Science and Technology, Department of Hydraulic and Environmental Engineering, N-7401 Trondheim, Norway, e-mail: kim.paus@ntnu.no
[3]COMSOL AS, Postboks 5673 Sluppen, N-7485 Trondheim, Norway, e-mail: bertil.nistad@comsol.com

Urban runoff is an engineering challenge with respect to quantity and quality in regions with cold climate. As the water flows across urban surfaces it collects particles, toxic metals, petroleum hydrocarbons, salts, and other anthropogenic contaminants that may have detrimental effects on receiving waters. The associated volumes of snowmelt and precipitation events make it impossible with today's conventional stormwater management to prevent urban floods, combined sewer overflows (CSOs), and an environmental dispersion of contaminants. In this context, recent research has shown that bioretention cells, or raingardens, are a promising stormwater best management practice (BMP). The BMP reduces stormwater runoff volumes and discharge peaks via infiltration, while simultaneously removing pollutants from stormwater by a variety of mechanisms. In this study we focus on the remediation capacity of water containing toxic metals in bioretention cells. The unsaturated zone has a significant remediation capacity, but there is a tradeoff between remediation capacity and water flux in the unsaturated zone. This optimization problem is a challenge to model because the peak flow into the bioretention cells creates sharp contrast between saturated and dry conditions in the vadoze zone. In this modeling exercise we demonstrate simulations of the wetting front in the unsaturated zone and indicate how this technology can be used to design bioretention cells in urban environments in cold climate regions.

Methods to identify groundwater interaction with river water in the catchment of the River Vantaa, Southern Finland

Anna-Liisa Kivimäki[1], Kirsti Korkka-Niemi[2], Anne Rautio[2], Kirsti Lahti[1], Veli-Pekka Salonen[2] and Heli Vahtera[1]

[1]Water Protection Association of the River Vantaa and Helsinki Region, Asemapäällikönkatu 12 B, 00520 Helsinki, Finland, e-mail: firstname.lastname@vesiensuojelu.fi
[2]Department of Geosciences and Geography, University of Helsinki, P.O. Box 64, FI-00014 University of Helsinki, Finland, e-mail: firstname.lastname@helsinki.fi

In Finland, research dealing with surface water and groundwater interactions has only recently started (Korkka-Niemi et al. 2011) and there is a great demand for further studies to understand the catchment-scale interactions with respect to the water supply, water quality and characteristics of aquatic environments. The River Vantaa is one of the raw water reserves for Finland's capital area (ca. 1 million people). In addition, there are 21 important aquifers used by the municipal water companies in close vicinity to river beds. Aquifers are related to glaciofluvial sand and gravel deposits, i.e. eskers or ice-marginal end moraine complexes.

In this study we introduce the results of low altitude aerial infrared survey (AIR) and hydrogeochemical and flow rate studies performed at the River Vantaa and its tributaries during 2010 - 2012, in order to identify and characterize the hydraulic connections between aquifers and river systems.

Based on AIR and site specific measurements, nearly 380 groundwater-surface water interaction sites along the catchment of the River Vantaa (270 km-long river system) were located (Nygård 2011 and unpublished data 2011).

Water fluxes between groundwater and river systems were identified and quantified with main ionic concentrations (n=109), SiO_2 (n=225), stable isotopes ($\delta^{18}O$, $\delta^{2}H$) (n=234) as well as river flow rate measurements (FlowTracker, ADCP Acoustic Doppler Current Profiler). A significant difference in SiO_2 and stable isotope ratios between groundwater and surface water was observed. Therefore, the chemical and isotope data can be applied to confirm the water exchange. At selected groundwater intake areas where risk of water quality deterioration during flood periods was recognized, water quality (NO_3-NO_2-N, DOC, turbidity) in the production wells was monitored with S::can sensors during springtime. Along with on-line water quality measurements at one hour intervals, river water level and hydraulic head within the well field were monitored.

In the low flow periods, the dominant proportion of water in the narrow and shallow streams in the catchment of the River Vantaa is groundwater originated from the adjacent aquifer. Risk management activities targeted to control bank infiltration during the maximum river flow periods are needed at several sites utilized by water works.

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Consequence of the frequency of water level readings for runoff measurement

Yrjö Kivinen

Finnish Environment Institute, P.O. Box 240, FI-00251, Helsinki, Finland, e-mail: yrjo.kivinen@ymparisto.fi

Runoff (the quantity of water flowing from a catchment in a given time) has been measured in Finland since the 1930 from small catchments (0,07 – 122 km^2). At the moment there are slightly fewer than 40 hydrological basins provided with measuring weirs, operated by the Finnish Environment Institute. Water level is measured with a limnigraph, nowadays equipped with a pressure sensor. This study compares the significance of the recording interval of water level readings. The accuracy of water level recordings is also important, because the water quality sensors nowadays play important role in water quality monitoring and modelling. Previous research in agricultural catchment areas has shown that the nutrient load generated from fields is most significant in very rapid pulses during the snowmelt period in spring, and flooding in autumn and winter.

The material used in this study is from Teeressuonoja catchment in Vihti (0.69 km2). The measuring weir water level data are recorded using a limnigraph and several pressure sensors from different manufacturers and for different recording intervals: from 1 to 60 minutes. Temperature and precipitation data come from the Finnish Meteorological Institute.

For runoff measurement the most important instrument is the measuring weir itself, so the key is to know exactly the position of the pressure sensor. Reference measurements of water level are recorded using a water level gauge, which may br affectected by ground frost under Finnish climate conditions. It is essential to know the gauge position, water level sensor position and the weir 0-point. This study also presents the methodology, whereby a single person can measure the elevation differences of the weir 0-point and the gauge, in a few minutes with millimetre accuracy using a daylight visible laser liner.

Trends of changes in flood regime in Latvia

Maris Klavins and Valery Rodinov

University of Latvia, Faculty of Geography and Earth Sciences, Raina blv. 19,
LV- 1586, Riga, Latvia, e-mail: maris.klavins@lu.lv

Studies of hydrological processes include not only analysis of observations, modeling of hydrologic regime, but a source of valuable information could be also analysis of historical information on hydrological (at first extreme) events – historical hydrology. The sources for historical studies of hydrological processes includes chronicles, church and parish archives, newspapers and others. In Latvia the first documentation of hydrological events can be dated back until 900 AD as mentioned of extreme floods and their brief description. In several chronicles major flood events has been documented at first for River Daugava. The same as well as other sources provides also information on drought (low water flow) timing. To obtain reliable information of past hydrological events it is important to compare different sources and to consider coincidence of information from several studies. Using such approach a record of major floods and low water periods on River Daugava for last millennia has been reconstructed.

Full reconstruction of time series of hydrology related events is timing on ice-break on River Daugava dating back to 1540, but measured records on River Daugava hydrological regime starts at 1864. The combination of historical records with direct measurements and climatic reconstructions supported analysis of recurrence of floods on River Daugava (Fig.).

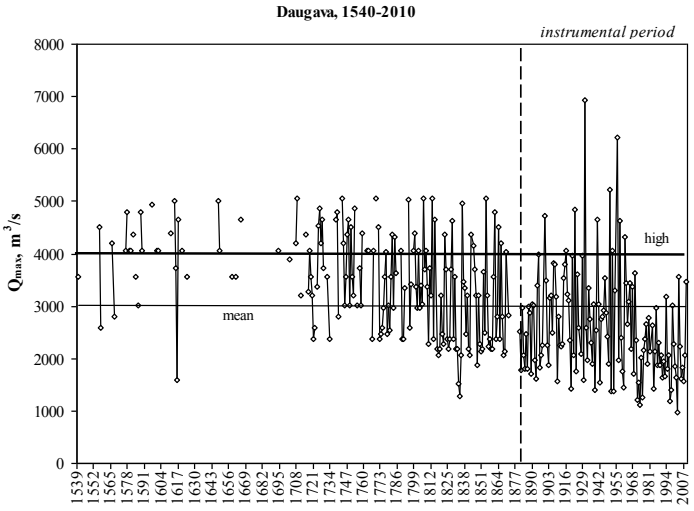

Figure. Reconstructed and observed River Daugava discharge trends (1540-2010)

Historical hydrological information also helps to identify weather conditions preceding extreme floods as well as judge on the possible impacts of climate change and reliability of information provided by hydrological models.

Stormwater modelling of pollutants wash-off from urban areas subcatchments

Tiit Koppel, Madis Maddison, Anatoli Vassiljev, Janek Laanearu and Raido Puust

Tallinn University of Technology, Department of Mechanics, Ehitajate tee 5, 19086, Tallinn, Estonia, emails: tiit.koppel@ttu.ee, madismaddison@gmail.com, anatoli.vassiljev@ttu.ee, janek.laanearu@ttu.ee, raido.puust@ttu.ee

Pollutant concentrations and water flow was measured in several urban area subcatchments of size 12.06 ha, 9.15 ha, 4.13 ha, 0.72 ha, 0.56 ha. The precipitations were drained by storm sewage in the capital of Estonia, Tallinn. A total of 19 rainfall-runoff events were monitored during one year. The 38 quality parameters were estimated for each subcatchment. Data collected has been used for the modelling of water flow and water quality.

The monitoring programme was performed during different seasonal storms in the year 2008. Five subcatchments have been selected to cover typical areas (transportation, two types of residential areas, commercial area), washed-off characteristics of 38 pollutants have been investigated for calculating the event mean concentrations and pollutant loadings. Water samples were collected according to the methodology described in Storm Water Sampling Guidance (SEPA, 1992). Flow-weighted composite samples were collected during the first 2 hours for the all sites to determine water quality characteristics. Series of individual samples have been taken to reflect the dynamics of total suspended solids (and for mineral and organic constituents). Water flow has been measured using automatic flow measurement devices. Modelling of the water flow and water quality has been accomplished by the EPA SWMM model.

Measurements results show that pollutants concentrations at the beginning of the flow events (first 20 minutes) were much higher than flow-weighted average concentration. Modelling results showed that water flow can be simulated acceptably by SWMM model. The adequate consideration of spatial and temporal variability of rainfall data is important for the modelling of flow in storm sewage (Laanearu *et al* 2009). The accuracy of water quality modelling depends on the precision of stormwater hydraulic modelling. Sometimes acceptable water flow modelling did not guarantee good results of water quality modelling. Measured concentrations reveal fluctuations which were not well described by the water quality modelling**.**

The main results proposed are

- Data for wash-off of the 38 pollutants have been obtained for different seasons in Estonian conditions.
- EPA SWMM model simulates acceptably water flow and water quality.
- Successful modelling of water quality is possible only with accurate modelling of water flow.

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On the near-bottom lake water temperatures in Finland in 1981-2010

Johanna Korhonen

Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland,
e-mail: johanna.korhonen@ymparisto.fi

Water temperature has a major influence on the biological activity and growth of aquatic organisms in lakes. Aquatic species all have preferred temperature ranges, which affects on abundance of each species. Temperature is also important because of its influence on water chemistry, which in turn affects biological activity.

The freezing and break-up records of Finnish lakes have revealed significant trends for later onset of ice cover and earlier melting (Korhonen, 2005). Based on the changes in ice cover duration and length of open water period, some questions have raised. Does shorter ice cover duration have effect on near-bottom water temperatures in lakes in winter time? Does the longer open water period have effect on near-bottom water temperatures in lakes in summer or autumn?

The questions raised above are tried to be answered with data available from Finnish lakes. The Finnish Environment Institute monitors lake water temperature profiles at ten sites. The longest continuous records are available in register since the 1970s, while some sites have data only since the 1990s. Many of the sites have some missing years in the data sets. The sites included in this study have records at least since the early 1980s. Two of the sites were already included in the publication of Finnish water temperatures in lakes and rivers in the 20th century (Korhonen, 2002). The sites are situated in central/eastern Finland and in Lapland. Bottom depths of the study sites vary from 40 to 65 meters. Data were analysed for the period of 1981-2010. From the 1980s measurements were conducted by 2 meter intervals below the depth of 20 meters, while before the 1980s only every 5 meters. Water temperature profiles were measured manually three times per month, every 10th, 20th, and 30th of an each month. There are gaps in measurements during early winter and late winter/early spring due to weak ice.

Analysed variables were near-bottom mean temperatures during late winter (March), as well as summer (July) and autumn (September) mean near-bottom temperatures, which were available for most of the years and sites. The mean temperatures were calculated as the average of three monthly measurements. Near-bottom temperatures do not vary considerably day to day, although these sparse measurements can result to slightly biased figures. Relationship between near-bottom temperatures and freezing dates, break-up dates and ice cover duration are also investigated.

Minima of near-bottom temperatures are usually measured in January while maxima in September. Minima are typically 1 to 2 ^{o}C degrees and maxima 8 to 12 ^{o}C depending on the depth and latitude of the lake.

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Traditional and non-traditional isotope tracers in monitoring artificial groundwater recharge: Virttaankangas aquifer in SW Finland

Nina Kortelainen[1], Yann Lahaye[1] and Hugh O'Brien[1]

[1]Geological Survey of Finland GTK, P.O. Box 96, FI-02151 Espoo, Finland, e-mail: nina.kortelainen@gtk.fi

Artificial recharge (AR) is a commonly used method for water treatment in regions with abundant surface water resources and glaciofluvial deposits. Mineral soil provides a medium for natural purification process for surface waters. The Virttaankangas AR project in the SW Finland aims to provide a reliable and long-term water supply for the inhabitants of the Turku area (Artimo et al. 2003). This aquifer has been extensively studied for its geochemical and traditional stable isotopic (^{18}O, ^{2}H, ^{13}C in dissolved in organic carbon DIC) composition by Kortelainen and Karhu (2009) before and after the initiation of the AR. The present study extends the range of isotopic tracers (Li, Mg, Sr and Pb) on the same sample sets. The prepared infiltration water is derived from the Kokemäenjoki River, North from the AR Site. River water was led to the infiltration ponds for the very first time in early September, 2010, which launched a unique isotope tracer test in the Virttaankangas area. Response of the aquifer to AR and thereby promoted changes in the isotopic and geochemical composition of the managed groundwater will be introduced in this paper.

The local groundwater and infiltrated river water of Virttaankangas AR system have distinct geochemical and isotopic composition for most isotope systems presented here. Especially the conservative isotope separation method based on oxygen and hydrogen isotopes were applied to monitor the infiltration process. Gradual increase in the proportion of infiltration water was recorded as a function of residence time of water and distance from the AR ponds. Dissolution of calcite from soil deposits activated instant alkalization reaction as the neutral infiltration water was derived into the soil formation. In less than a month, the recharged water attained saturation respect to calcite and pH increased up to natural level of this aquifer, being about 9. Dissolution of calcite with a distinct carbon isotope value accompanied with the change in the ^{13}C of DIC in water. No organic matter decomposition has yet been observed in AR process. Isotopic composition of Li, Mg, Sr and Pb in groundwater is characterized by the dominant weathering reaction between groundwater and aquifer mineral material representing ambient bedrock geology, and thereby generally gives very constant isotope signature as long as the geochemical balance in the aquifer is attained. In the infiltrated river water, on the other hand, some seasonal variations are recorded. This corresponds to mixing between different input waters from the catchment area. Introducing surface water into the aquifer changes the geochemical state between water and mineral soil, temporarily at least. Non-traditional and traditional isotope systems are powerful and complementary tools to monitor and evaluate an aquifer geochemistry as it re-balances itself during an AR.

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Active wetlands: assessments of nutrient loading and cost-effectiveness of constructed wetlands and chemical amendments

Jari Koskiaho[1], Markku Puustinen[1] and Kauko Koikkalainen[2]

[1]Finnish Environment Institute, Freshwater Centre, PO Box 140, FIN-00251 Helsinki, Finland, e-mail: jari.koskiaho@ymparisto.fi, markku.puustinen@ymparisto.fi
[2]MTT, Economic Research, Latokartanonkaari 9, FIN-00790 Helsinki, Finland, e-mail: kauko.koikkalainen@mtt.fi

Constructed wetlands (CWs) were reckoned to be a promising tool for the treatment of agricultural runoff in 1995 when Finland joined the EU and the first period of the Finnish Agri-Environmental Protection scheme (FAEP) was launched. Finnish CW research results (Koskiaho et al. 2003) revealed that the anticipations were not unrealistic, high annual retentions (up to 70%) were indeed measured in some cases. However, the studies also suggested that the prerequisite for good functioning of a CW was high CW-to-watershed area ratio. In Finnish CW design guidelines, largely based on the Finnish CW studies, it was recommended that this ratio should be 2% or more. However, in the present FAEP stipulations for CWs to be eligible for subsidy, the ratio is only 0.5% and in real-world planning cases even such a low ratio is often hard to achieve. This dilemma is due to the typical situation in Finnish agricultural watersheds; the fields and thus favourable sites for CWs are often located near larger streams in their lower reaches, which means that the above watershed is in many cases large, even tens of km^2:s. On the other hand, farmers are understandably reluctant to convert very large field areas into CWs for fear of economic losses. Meanwhile in upper reaches where the above watershed and thus required CW area would be smaller, there are often no –or very few– farms with fields. Due to the above reasons, Finnish agri-environmental CWs tend to be small in relation to their catchments and their nutrient retention efficiency presumably rather poor.

The Active Wetlands Project has identified possible solutions for this drawback. The project concentrates especially on testing the potential improvement of phosphorus (P) retention in small-sized wetlands with chemicals commonly used in waterworks and wastewater treatment plants to precipitate solids, organic matter and P. In addition to on-site testing (work package 2), the project will also conduct catchment-scale modelling and assessments (work package 3) to estimate the cost-efficiency of, not only the tested active measures, but also CWs in general in retaining the nutrients escaped from agriculture. The models used in WP3 were SWAT (Arnold et al. 1998) and VIHMA (Puustinen et al. 2010).

Derived from the results of these work packages, one of the objectives of the Active Wetlands project is to conclude and recommend how to incorporate agricultural wetlands and their active measures in the current water management policies, including the FAEP scheme.

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Using linear mixed models in lake management and decision making

Niina Kotamäki, Anita Pätynen, Olli Malve, Antti Taskinen and Timo Huttula

Finnish Environment Institute, Modelling and Assessment Unit, P.O.Box 140, 00251 Helsinki, Finland, e-mail: niina.kotamaki@environment.fi, anita.patynen@environment.fi, olli.malve@environment.fi

Using linear regression models requires several assumptions concerning the normality and homoscedasticity of the variables, independence of observations and deterministic nature of variables (Zuur *et all.* 2009). In natural sciences violating these assumptions is regrettably common but instead, data with a complex, multilevel, hierarchical structure could be analyzed properly with mixed effects models. In a linear mixed-effects model, responses from a subject are thought to be the sum (linear) of so-called fixed and random effects. If an effect affects the population mean, it is fixed, whereas random effects contribute only to the covariance structure of the data (SPSS).

The eutrophication of European lakes was studied using a linear mixed effects model which was fitted to 461 European lakes. The main effects of phosphorus and nitrogen concentrations and temperature were set as fixed variables as it is known they have a linear relationship with chlorophyll *a* concentration, the main indicator of eutrophication. The effect of total phosphorus, total nitrogen and water temperature on chlorophyll *a* concentrations vary within WFD affiliated lake types and therefore they were treated as random variables.

The lake data structure was three-way nested as there were several lakes within every lake type and from every lake multiple chlorophyll *a* samples were taken. When using linear mixed effects model for nested data, it was possible to substantially decrease the variation of the data. By selecting both the fixed effects and covariance structure properly we got more reliable estimates of chlorophyll *a* concentrations.

In addition, Bayesian inference with Markov Chain Monte Carlo (MCMC) method was used to simulate the posterior distribution of the model parameters thus giving a more realistic assessment of the model uncertainty.

Based on the data analysis of the European data set, the effect of warmer temperatures on eutrophication proved to be positive. Thus, in warmer climatic conditions lower in-lake nutrient concentrations are needed to achieve, or maintain, the good ecological condition of a lake.

The mixed effects chlorophyll *a* model with temperature effect was then implemented in the LakeLoadRespose (LLR) tool that has been developed to ease the decision making in lake management. LLR tool is easy to use and it is freely accessible through the Internet (http://lakestate.vyh.fi/). As LLR produces water quality predictions with statistical confidence intervals it gives more insight for the management actions to be taken. Also, low data requirements makes it helpful tool for less studied lakes.

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Uncertainties in estimation of water balance of the Curonian Lagoon

Jurate Kriauciuniene and Darius Jakimavicius

Laboratory of Hydrology, Lithuanian Energy Institute, Breslaujos 3, LT-44403 Kaunas, Lithuania, e-mail: hydro@mail.lei.lt

The Curonian Lagoon is the largest fresh water basin in Lithuania. The greater part of the Curonian Lagoon belongs to Russia (1171 km^2), and Lithuania has only 413 km^2. The Curonian Lagoon (territory of NATURA 2000) differs not only by its area but also by its landscape and uniqueness of fauna. During the development of Klaipeda State Seaport, the Northern part of the Curonian Lagoon which connects the Lagoon with the Baltic Sea has been dredged and the quays have been reconstructed and newly constructed. The long-term water balance of the Curonian Lagoon was calculated in the period of 1961-2007 for evaluation of impact of anthropogenic activity and climate change (Jakimavicius and Kovalenkoviene, 2010).

It is essential to evaluate the impact of uncertainties of water balance elements on the results of calculation of the Curonian Lagoon water balance. Three balance elements (river inflow, precipitation and evaporation) are not precise because they are calculated according to the data of various measurements. It was determined that the measurement errors of water balance elements are as follows: river inflow - ±10%, precipitation - ±5% and evaporation from the Curonian lagoon - ±10%. The selection of these parameters determines the accuracy of calculation of the Curonian Lagoon water balance. In this study the uncertainty analysis of the water balance calculation results (change in the volume of the Curonian Lagoon) was assessed using best estimate methodology and statistical program code SUSA (Software System for Uncertainty and Sensitivity Analysis) (Kloos and Hofer 2002). The uncertainty analysis of the water balance results was performed in the following order: description of water balance elements; estimation of their range and distribution pattern; generation of input parameter sets; water balance calculation according to the generated input parameter sets; analysis of balance results estimating water balance elements, which have the greatest impact on the water balance results.

The calculation of change in the volume of the Curonian lagoon was performed according to 100 sets of randomly generated water balance elements. The dispersion of changes in volume calculated according to the distributions of 100 sets is significant (from -0.930 to 2.084 km^3), while the average of the calculated balance according to the data from the 1961–2007 period is 0.515 km^3. The analysis of the impact of water balance elements on the final result (the volume changes of the Curonian lagoon) revealed that the river inflow impacts the results the most (the significance of parameter is 0.9), while the impact of precipitation (0.02) and evaporation (-0.1) is less significant. When calculating the water balance of the Curonian lagoon, it is very important to take notice of the correct evaluation of river inflow, because the impact of this parameter on the results is the most significant.

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Hydrological effects of intensive biomass harvesting and snow melting

Eero Kubin[1], Josef Krecek[2], Jiri Kremsa[2] and Tanja Murto[1]

[1]Finnish Forest Research Institute, Oulu, Rakentajantie 3, FI-91500 Oulu, e-mail: Eero.Kubin@metla.fi, Tanja.Murto@metla.fi

[2]Czech Technical University in Prague, Faculty of Civil Engineering, Department of Hydraulics and Hydrology, Thakurova 7, 166 29 Praha 6, Czech Republic, e-mail: Jkrecek@email.cz,kremsa@seznam.cz,

The availability and the quality of water are strongly influenced by forests. The relationship between forests and water is therefore a critical issue that must be accorded high priority. In Finland forests cover 74% of the land area and the processes of accumulation and melt of snow are controlled mainly by boreal forest systems. Snow phenomena significantly affect the water cycle, flood occurrence and water resources recharge. However, too little research has concentrated on the impacts of forest harvesting on snow accumulation and melt.The forests are stabilizing soils and protecting watersheds.

The accumulation and melt of snow was investigated at two adjacent sites in Paljakka Research Forest in the stand of mature spruce (*Picea abies*) and in the open field (elevation 350 m). The observation of snow-depth and snow-water equivalent was completed with standard daily meteorological data of the site. In the mature boreal spruce forests, the snow cover lasts on average for 235 days a year, with maximum water equivalent 165 - 402 mm. Intensive changes of snow cover in the separately investigated spruce stand show the snow is more thick (16 %), and lasts approximately one month longer compared with open area.

In the Oulu Research Unit of Metla, we have an ongoing project “Groundwater and catchment impacts of stump harvesting” in which we have studied the effects of clear cutting and intensive energy wood harvesting on hydrology and nutrient cycle. Snow is an important storage component of the hydrological cycle and its influence is evident in energy wood harvesting areas. For evaluation, the effect of stump removal on hydrological processes the groundwater and precipitation-runoff model will also be applied to the experiment areas.

Nowadays in the boreal forests the intensive biomass harvesting is strongly increasing and likely to cause progressive change in the character of the forests addressing the need to better understand hydrological cycle. For this reason to develop the best forest management practices to protect water quality is becoming more and more important. The study results will be of benefit to forestry organisations and political decision makers in connection with decisions involving the sustainable use of forest based energy.

Intensive biomass harvesting - leaching of nutrients and hydrological processes

Eero Kubin[1], Tanja Murto[1] and Jiri Kremsa[2]

[1]Finnish Forest Research Institute, Muhos, Kirkkosaarentie 7, FI-91500 Muhos, Finland, e-mail: Eero.Kubin@metla.fi, Tanja.Murto@metla.fi
[2]Czech Technical University in Prague, Faculty of Civil Engineering, Department of Hydraulics and Hydrology, Thakurova 7, 166 29 Praha 6, Czech Republic, e-mail: kremsa@seznam.cz

The use of forest biomass for energy is becoming more and more prominent part of forest management in Finland. In addition to harvesting logging residues stumps are also uplifted for energy, annual area reaching up over 10 000 ha. Because of good energy quality and other benefits stump harvesting area is rapidly increasing. To get more understanding about possible risks to water quality the new project was launched to evaluate hydrological processes, nutrient leaching and other environmental effects.

The study was carried out in three phytogeographical areas in Finland. The treatments repeated with three replicates on each location are: 1) Uncut control 2) No logging residue removal, patch mounding and spruce planting 3) Clear-cut, 70 % logging residue removal, patch mounding and spruce planting 4) Clear-cut, 70 % logging residue removal, stump removal retaining 25 stumps/ha, patch mounding, spruce planting 5) All stumps and logging residues harvested. For monitoring groundwater, altogether 249 wells were set before cutting in 2006 after the radar scanning of the groundwater table. In 2010 catchment areas from north-eastern Finland were also implemented into the project.

Clear-cutting and subsequent stump harvesting result in nitrate leaching to the ground water more than other elements. Increasing started a year after harvesting and still continues. In addition to leaching hydrological processes are evaluated with the groundwater and precipitation-runoff models applied to the experiment areas. In the conference the experimental layout and results in context of utilizing boreal forests will be discussed.

Effect of groundwater availability on riparian vegetation

Lenka Kuglerová[1] and Roland Jansson[1]

[1]Landscape Ecology Group, Department of Ecology and Environmental Science, Umeå University, SE-90187 Umeå, Sweden, e-mail: lenka.kuglerova@emg.umu.se, roland.jansson@emg.umu.se

Riparian zones form the interfaces between terrestrial and aquatic environments and are important in maintaining biodiversity at the scale of landscapes. In boreal Swedish forests riparian zones are considered to be hotspots of plant species richness especially in comparison with surrounding forest habitats. The flow regime of adjacent waterways has generally been considered the main driver of riparian vegetation composition, whereas the role of input from the surrounding catchment has been neglected, despite that riparian zones are at the receiving end of flows of energy and matter.

We studied how influx of groundwater from upland parts of the catchment affects riparian plant species composition (vascular plants and bryophytes) and abundance along a stream size gradient, ranging from first order headwater streams to a 7th order major river, supplemented by non-riparian sites. We selected sites with and without groundwater discharge using a hydrological model describing groundwater flow paths across the catchment to test the hypothesis that higher groundwater availability maintains more species-rich communities. We also investigated soil chemical and physical characteristics (e.g. pH, productivity and substrate grain size) and variables describing the influence of the stream (disturbance, inundation, soil erosion and deposition) to infer the relative importance of upland and stream-related processes.

Vascular plant species richness was significantly higher at riparian sites characterized by groundwater discharge at all stream sizes. In general, species composition at the dry sites was a subset of the groundwater discharge sites. Riparian sites with groundwater discharge harbour more diverse communities up to higher elevations further away from the stream edge than comparable sites without discharge. Soil pH was higher at discharge sites at all stream sizes. Further, soil pH at these sites was constant with increasing distance from the stream while pH gradually decreased with increasing distance from the stream at sites with deeper groundwater tables. Our results suggest that river-related processes such as floods and inundation explain high species richness of riparian zones in boreal regions to great degree but factors related to upland processes should not be overlooked. As interfaces between terrestrial and aquatic habitats, riparian zones occupy critical positions in the landscape, harbouring a large proportion of regional diversity. This makes riparian zones important indicators of environmental change.

Two-dimensional solute transport for pulse type input point source through inhomgeneous porous medium : Analytical Approach

Atul Kumar[1], Dilip Kumar Jaiswal[2] and R. R. Yadav[3]

Department of Mathematics and Astronomy, Lucknow University, Lucknow-226007 Utter Pradesh, India,
e-mail: [1]atul.tusaar@gmail.com, [2]dilip3jais@gmail.com; [3]yadav_rr2@yahoo.co.in

Abstract In the present study, to solves the conservative solute transport equation for a solute undergoing convection, dispersion, retardation in a two-dimensional inhomogeneous porous medium. The solute dispersion parameter is considered uniform in the present study while the velocity of the flow is considered space dependent. Retardation factor is also considered. The velocity of the flow is considered inversely proportional to the space dependent function while retardation factor is considered inversely proportional to square of the velocity of the flow. Analytical approach introduced for pulse type input pint source. Former one is for uniform input point source and latter case is for varying input point source where the solute transport is considered initially not solute free from the domain. In other word, domain is initially polluted. The variable coefficients from conservative solute transport equation have reduced into constant coefficients with the help of some transformations, which introduced by new space variables. The Laplace transformation technique is used to get the analytical solutions of conservative solute transport equation for both the cases. Figures are drawn by Mathematica Software 7.0 and illustrating the dependence of the solute transport upon velocity, dispersion and adsorption coefficient. Keywords: conservative solute transport equation, Retardation Factor, Inhomogeneous Medium, Pulse type point source, Diffusion Processes.

Managed aquifer recharge in community water supply: international and finnish experiences

Vuokko Kurki[1] and Tapio S. Katko[2]

Department of Chemistry and Bioengineering, Tampere University of Technology (TUT), P.O. Box 541, FIN-33101 Tampere, Finland, e-mail: [1]vuokko.kurki@tut.fi, [2]tapio.katko@tut.fi

This paper analyses the use of managed aquifer recharge (MAR) in community water supply in Finland as well as presents some international experiences from its use. MAR has been practised since the 19th century at least in England, France, Germany, Scotland, Sweden and the USA. The first experiments in Finland were made in 1912-1914. However, the method did not see wide use until the 1970s when the great majority of the Finnish MAR plants were built. (Kivimäki & Suokko 1996) At the moment there are 26 MAR plants in Finland excluding the 28 used for bank filtration.

The paper presents the different technical methods used to implement MAR: bank filtration, basin filtration, sprinkling and well injection. Yet, the main objective is to draw an overall picture of the use of MAR in community water supply in Finland and its prevalence internationally.

MAR is an internationally known concept that has different applications. In Finland most MAR plants are drinking water supply treatment units. In Germany, on the other hand, MAR is also used to displace unwanted bank filtrate and for subterranean water storage, and in Australia and USA for waste water treatment as well. (Committee on Sustainable... 2008, Kivimäki & Suokko 1996)

The historical debate and political alignments around the question of whether water supply should be based on groundwater or surface water will be described for background. In that connection, the importance of groundwater and its conservation will also be discussed. What is the contribution of MAR as a water treatment or storage method?

Finally, the paper sheds light on the MAR-related legislation in Finland and the European Union. For example, the quality requirements for injected water have not been established in Finland. Yet, the legislation on groundwater conservation is rather strict.

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Hydrological modelling of Lake Engure catchment

Līga Kurpniece[1, 2], Inese Latkovska[1, 2] and Elga Apsīte[1]

[1]University of Latvia, Faculty of Geography and Earth Sciences, Raiņa bulv. 19, Rīga LV-1586, Latvia, e-mail: ligakurpniece@gmail.com
[2]Latvian Environment, Geology and Meteorology Centre, Maskavas Str. 165, Riga, LV-1019, Latvia

Lake Engure is located in western part of Latvia; it is lagoon lake with catchment area 644 km^2. Water inflow into the Lake Engure is mostly from the tributaries flowing from western part of catchment, therefore it is important to simulate runoff in the particular river basins.

The hydrological HBV model (Bergstrom 1976) applied to the four largest river basins flowing into Lake Engure: Dursupe River (168 km^2), Dzedrupe River (266 km^2), Jurģupe River (67 km^2) and Kalnupe River (36 km^2). Most of the river basins in this catchment are ungauged. There is only one monitored river basin in Lake Engure catchment area. Dursupe River basin at hydrological station Jaunplavas was pilot basin for this research.

Hydrological HBV model was calibrated and validated for Dursupe-Jaunpļavas, catchment area 138 km^2. Calibration period was 1961-1980 and validation period 1981-1989.
A statistical criterion R^2 (Nash and Sutcliffe 1970) was used to asses calibration and validation results. Statistical criterion R^2 for the calibration period was 0.69 and for the validation period 0.67.

The input meteorological data for the HBV model are daily mean air temperature and daily precipitation at three meteorological stations: Rīga, Mērsrags and Stende. Long-term monthly average values of evaporation was used from Ķemeri station as well. Hydrological data series were taken daily river discharge at Dursupe – Jaunpļavas. Hydrological and meteorological data was obtained from "Meliorprojekts" and Latvian Environment, Geology and Meteorology Centre.

After model parameters obtained for Dursupe River basin at Jaunpļavas was applied to simulate runoff for whole Dursupe River basin and other three ungauged river basins: Dzedrupe, Jurģupe and Kalnupe.

Long-term meteorological data series admitted to extent river flow series in past and nowadays for the four river basins. Climate data series 2071-2100 (daily air temperature and precipitation) as the input data into the hydrological model was used to simulate river runoff in future. Therefore data from global climate model HadAM3H with regional climate model Rossby Centre Atmosphere Ocean was prepared for two scenarios A2 and B2 (Seņņikovs and Bethers 2009).

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The region lake contest – some assessments

Esko Kuusisto

Finnish Environment Institute, The Water Centre, Box 140, FIN-00251 Helsinki, e-mail: esko.kuusisto@ymparisto.fi

The region lake contest was held in Finland in 2011. It was organized by the Finnish Environment Institute (SYKE) and Suomi Express television program of the Finnish Broadcasting company (YLE). The procedure of electing regional lakes was divided into two stages. In the first stage people were asked to suggest and state reasons for lakes they thought would qualify for region lakes. This stage lasted about five months; some 500 suggestions regarding around 150 lakes were given. The web service for these suggestions was Järviwiki (Lakewiki), which is founded and maintained by SYKE. Järviwiki was created with the aim of sharing information on Finland's lakes, to raise awareness and promote the protection of our waters.

Based on the suggestions during the first stage, an expert jury nominated three candidate lakes for each region to the second stage of the contest. It was carried out as an SMS and postcard voting, lasting two weeks. The lake which collected most votes in each of the 19 regions was announced as a region lake. This paper discusses the reflections from media and the public during and after the contest. Did we succeed in increasing public awareness about the lakes of our country? What was the overall meaning of the contest?

Climate change scenarios of precipitation extremes in RCM simulations over Europe evaluated by the region-of-influence method

Jan Kyselý[1], Ladislav Gaál[1,2] and Romana Beranová[1]

[1]Institute of Atmospheric Physics AS CR, Prague, Czech Republic, e-mail: kysely@ufa.cas.cz
[2]Institute of Environmental Engineering, ETH Zurich, Switzerland

The study examines climate change scenarios of precipitation extremes over Europe for the late 21st century (2070-99) in an ensemble of regional climate model (RCM) simulations from the ENSEMBLES project. Precipitation extremes are considered at a wide range of time scales from hourly to multi-day amounts and in winter and summer seasons. The region-of-influence method is used for estimating distributions of extremes, which leads to spatial patterns that are smoothed compared to a local analysis (when distributions are fitted for each grid box separately). We focus on uncertainties of the climate change scenarios (related to differences amongst the RCM simulations) and dependence of the results on the time scale of precipitation aggregation (from hourly to multi-day). Northern Europe is a region in which the projected changes in precipitation extremes are particularly large and relatively robust in the RCM ensemble.

Salmonid enhancement programs of the Rivers Oulujoki and Iijoki

Esa Laajala, Arto Hirvonen, Anne Laine and Timo Yrjänä

North Ostrobothnia Centre for Economic Development, Transport and the Environment, P.O. Box 86, FI-90101 Oulu, Finland, e-mail: esa.laajala@ely-keskus.fi

The rivers Oulujoki and Iijoki are two of the most important former Baltic salmon rivers draining into the Finnish side of the Bothnian Bay. Both rivers were harnessed for hydropower development during the 1940s-1960s. At that time, the production of electricity was seen as an overriding national interest and it generally took precedence over other factors. As a consequence, the natural salmon stock was extirpated in the river Oulujoki. The Iijoki stock, on the other hand, has been maintained in hatchery conditions ever since. Compensation stockings have been made in the river mouths and coastal areas to support the sea and coastal fishery.

In the River Oulujoki, four small tributaries provide c. 50 ha of suitable production areas. In addition, there are between 0 and 50 ha potential production areas in the main stem, their width depends on the minimum flow and the short-term regulation practice of the river. The enhancement program of the river Oulujoki was originally started several years ago by a fishway feasibility study, socio-economic survey and several biological studies. The final phase, the fishway designing process, was implemented during 2009-2011. The future program consists of step-by-step options for bypassing the dams and supporting measures; including habitat restoration, adult transfer and fry stocking.

The respective program at the River Iijoki (2008-2013) is very similar, excluding habitat restorations since the spawning and nursery areas are more extensive, over 700 ha. The main characteristic of project co-operation has been the reconciliation of natural salmonid reproduction and hydropower production.

The contract of collaboration demands a broad approach to enhancement and sustainable development. In both rivers there have been many projects to discover best practices and solutions, and more and more will be done to achieve all the milestones and goals. In addition to the results, the combination for cooperation involving municipalities, authorities and power companies will be discussed. So far, the various projects have proved successful in bringing together authorities, hydropower companies, local organizations, and expertise from a range of institutions in a joint effort to tackle these multifaceted and multidisciplinary problems.

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Speciation of Small Aluminium Silicate Clusters in Aqueous Environment

Giorgio Lanzani[1], Tiina Leiviskä[2], Ari P. Seitsonen[3], Carole A. Morrison[4], Jaakko Rämö[5], Kari Laasonen[6] and Simo O. Pehkonen[7]

[1]Thule Institute, University of Oulu, P.O. Box 7300, FIN-90014 Oulun Yliopisto, Finland, e-mail: giorgio.lanzani@oulu.fi
[2]Department of Process and Environmental Engineering, University of Oulu, P.O. Box 4300, FIN-90014 Oulun Yliopisto, Finland, e-mail: tiina.leiviska@oulu.fi
[3]Institute of Physical Chemistry, University of Zurich, Winterthurerstrasse 190, CH-8057 Zurich, Switzerland, e-mail: ari.p.seitsonen@iki.fi
[4]School of Chemistry and EaSTCHEM Research School, The University of Edinburgh, Joseph Black Building, West Mains Road, Edinburgh, Scotland EH9 3JJ, United Kingdom, e-mail: c.morrison@ed.ac.uk
[5]Thule Institute, University of Oulu, P.O. Box 7300, FIN-90014 Oulun yliopisto, Finland, e-mail: jaakko.ramo@oulu.fi
[5]Department of Chemistry, Aalto University, P.O. Box 16100, FIN-00076 Espoo, Finland, e-mail: kari.laasonen@aalto.fi
[6]Chem. Eng. Program, Masdar Institute of Science and Technology, P.O. Box 54224, Masdar City, Abu Dhabi, UAE, e-mail: spehkonen@masdar.ac.ae

The chemistry of aluminium silicates in water is quite unknown, although it is at the basis of many chemical and industrial processes. There are still several uncharted factors concerning the structures and chemical composition of these species during coagulation stage of water treatment process that remain to be clarified, in order to maximise the efficiency of these chemicals in an environmentally safe usage.

Our group has previously integrated traditional and state-of-the-art methods in a novel way to study the aquatic chemistry of aluminium clusters in order to develop novel materials and energy efficient water treatment chemicals for coagulation and adsorption purposes (Lanzani, 2012).

Here in, zeta potential and spectroscopic techniques have been combined with computational methods to investigate mechanics to investigate directly the hydrolysis products of aluminium silicates in aquatic environments. The major goal of this study is to elucidate the progress of hydrolysis and polymerization of aluminium silicate complexes and study the kinetics of these reactions. Experimentally, this has required systematic spectrometric studies with respect to, Al/Si concentration and time. Structural data for the species detected experimentally have been sorted out using computational methods.

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Long-term changes in discharge and ice regime in Latvian river basins and regional peculiarities

Inese Latkovska[1,3], Elga Apsīte[1], Didzis Elferts[2], Līga Kurpniece[1,3] and Elza Žumbure[1]

[1]University of Latvia, Faculty of Geography and Earth Sciences, Raiņa bulv. 19, Rīga LV-1586, Latvia, e-mail: inesepallo@inbox.lv
[2]University of Latvia, Faculty of Biology, Kronvalda bulv. 4, Rīga, LV-1586, Latvia
[3]Latvian Environment, Geology and Meteorology Centre, Maskavas street 165, Riga LV-1019, Latvia

The river discharge and ice regime are one of the most important indicators to evaluate the climate changes. The global warming and accordingly changes of air temperature and precipitation significantly affect the ice regime and the river discharge pattern. The records of the last two centuries of ice break up dates on the rivers in the Northern hemisphere provide consistent evidence of later freezing and earlier break up (Magnuson et al. 2000). However, in Latvia studies of ice regime of river and lakes were developed in 30-ties and 40-ties by P. Stakle and E. Kanaviņš and in 60-ties by L. Glazačeva. The latest study about largest Latvian rivers of freezing and break-up date and discharge regime of rivers was performed by Kļaviņš et al. (2009). The aim of this study is to analyse discharge and ice regime changes and its regional peculiarities in the territory of Latvia.

The study focuses on 5 largest Latvian rivers (Salaca, Gauja, Daugava, Lielupe and Venta) and 35 medium and small river basins which are located in different hydrological districts, and closer meteorological observation stations (daily air temperature and precipitation records). All data were obtained from the Latvian Environment, Geology and Meteorology Centre. Variations in ice cover data (freezing and break up data, maximum ice thickness, winter severity index) and discharge regime and it regional differences on the selected rivers are investigate comparing the data of period from 1945 to 2002.

Study results show air temperature warming over all the territory of Latvia especially in winter and autumn seasons and also precipitation increase more in cold period of the year. Due to changes in air temperature and precipitation the main tendency in the river discharge change is a decrease of spring floods and increase of winter runoff in proportion to the total runoff of the year. According to the regional peculiarities in Latvia the most important changes in river discharge are detected for Central hydrological district, but smallest for East district.

Study results present that calculated severity index show that during the last decades more warmest and mild winters were observed, what means that warm winters cause later freeze up dates, shorter ice cover duration and smallest maximum ice thickness. The main regional peculiarities according to ice regime are determined to West – East direction.

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Improving the accuracy of a grid-based distributed hydrological model using sub-grid scale parameterization of elevation data

Hannu Lauri[1] , Timo Räsänen[2] and Matti Kummu[2]

[1]EIA Finland Ltd, Tekniikantie 21 b, 02150 Espoo, Finland, e-mail: hannu.lauri@eia.fi
[2]Water & Development research group, Aalto University, P.O.Box 15200, 00076 Aalto, Finland, e-mail: firstname.lastname@aalto.fi

In grid-based spatially distributed hydrological models the selected grid cell size affects the model computation results. The effect is not obvious, and depends on how the model uses elevation data in runoff and river flow computation. In this study the effect of grid cell size was investigated using the VMod hydrological model application for a large river catchment located in South-East Asia. The specific aims were to (a) find out how the model grid resolution affects model results and (b) find a method for parameterization of sub-grid scale elevation variation to improve the modelling results.

To investigate the effect of DEM resolution three model grids with resolutions of 1, 5 and 10 km were compiled for the test catchment. Two main factors related to the upscaling of DEM from lower to more coarse resolution were identified: (1) the soil slope will get smaller, and (2) the computed drainage network will get shorter as the grid cell size is increased. Corrections to these elevation averaging -based effects were introduced to VMod by a modification of existing model parameters. Soil slope for each grid cell was set to model by using a slope value computed as an average of grid cell slopes from smaller scale DEM instead of computing the slope from the application scale grid. River lengths were also set to the coarse scale model grid cells by using river length values computed from a smaller scale model drainage network.

The results obtained from the computations using 5km and 10km resolution grids with the above sub-grid scale parameterization yielded improved results when compared with the situation without modified parameterization. The obtained results for coarser grid model versions were very near the 1km resolution model result, showing that the tested sub-grid scale parameterization was successful in removing at least part of the problems caused by averaging of DEM in model grid construction.

In literature the averaging of DEM slope (instead of elevations) from finer resolution DEM to coarse resolution model has been used at least by Yang et al. (2002). Their application of the method is used in hill-slope analogy models and does not directly apply to grid-based models. Upscaling of river length data to coarser model from a higher spatial resolution DEM has been successfully attempted by Paz and Collischonn (2007). The results showed increase in model performance similarly to the results obtained in this study.

The presented sub-grid scale parameterization allows the use of a larger grid cell size in model computation, and obtains results that are comparable with the model using a smaller grid size. This enables, for example, a coarse resolution model with fast computation time to be used in calibration of a fine resolution model with a much longer run time. Another benefit is getting better results for large catchment models, where fine grid cell resolution is not possible due to a large model grid size.

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Impact of the climate changes to shallow groundwater in Baltic artesian basin

Didzis Lauva[1], Peteris Bethers[2], Andrejs Timuhins[2] and Juris Sennikovs[2]

[1]Latvia University of Agriculture, Jelgava, Latvia, e-mail: didzis@lauvadidzis.com
[2]University of Latvia, Zellu 8, Riga, Latvia, e-mail: tim@modlab.lv

The purpose of our work was to find the long term pattern of annual shallow ground water changes in region of Latvia, ground water level modelling for the contemporary climate and future climate scenarios and the model generalization to the Baltic artesian basin (BAB) region.

Latvia is located in the middle part of BAB. It occupies about 65'000 square kilometers. BAB territory (480'000 square kilometres) also includes Lithuania, Estonia as well as parts of Poland, Russia, Belarus and the Baltic Sea. Territory of BAB is more than seven times bigger than Latvia. Precipitation and spring snow melt are the main sources of the ground water recharge in BAB territory.

The long term pattern of annual shallow ground water changes was extracted from the data of 25 monitoring wells in the territory of Latvia. The main Latvian groundwater level fluctuation regime can be described as a function with two maximums (in spring and late autumn) and two minimums (in winter and late summer).

The mathematical model METUL (developed by Latvian University of Agriculture) was chosen for the ground water modelling. It was calibrated on the observations in 25 gauging wells around Latvia. After the calibration we made calculations using data provided by an ensemble of regional climate models, yielding a continuous groundwater table time-series from 1961 to 2100, which were analysed and split into 3 time windows for further analysis: contemporary climate (1961-1990), near future (2021-2050) and far future (2071-2100). The daily average temperature, precipitation and humidity time series were used as METUL forcing parameters. The statistical downscaling method (Sennikovs and Bethers, 2009) was applied for the bias correction of RCM calculated and measured variables.

The qualitative differences in future and contemporary annual groundwater regime are expected. The future Latvian annual groundwater cycle according to the RCM climate projection changes to curve with one peak and one drought point.

The METUL parameters were extrapolated to whole BAB region and the annual groundwater cycle was constructed. Pointwise verification was performed for the modelled groundwater level outside of territory of Latvia.

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The shift of annual long-term groundwater table fluctuation regime in Latvia

Didzis Lauva, Inga Grinfelde, Arturs Veinbergs, Kaspars Abramenko, Valdis Vircavs, Zane Dimanta, Ilva Vitola and Agnese Gailuma

Faculty of Rural Engineering, Latvia University of Agriculture, 19 Akademijas Str. Jelgava, LV-3001, e-mail: didzis@lauvadidzis.com

Various annual regimes of shallow groundwater levels significantly and differently affect agricultural and forestry production. In the previous work (Lauva et al. 2012) we have proven that in the reference period (1961-1990) the annual long-term monthly mean shallow groundwater regime is M-shaped with two maximums in the December and April and two minimums in March and August. In the future period (2070-2100) the modelled regime is Λ-shaped with one maximum in the winter (in different months depending on the magnitude of continentality) and one minimum in the late summer, August. Likewise, the spatial distribution of different temporal characteristics of the groundwater regime in chosen future period was distinguished.

The aim of the research is to find and characterize the annual long-term monthly mean shallow groundwater shift timeframe in Latvia. Seven sites with different geographical and hydrogeological characteristics were chosen for analysis. Groundwater levels were modelled with groundwater level modelling software METUL (Krams and Ziverts, 1993) which was chosen as best known and most appropriate model for Latvian climate conditions for modelling future daily groundwater levels using daily temperature, precipitation and humidity. The long-term annual shallow groundwater regime in the future period for each site is characterized with median from 14 regional climate models, which were previously calculated by Sennikovs and Bethers (2009). The approach which counts maximums and minimums inside of moving timeframe has been created allowing assuming the start, the end and the length of regime shifting timeframe for each site.

The results show that the shift of the long-term annual shallow groundwater regime in different sites occurs in different time frames and it is dependent of continentality and distance to the Baltic Sea including the Gulf of Riga. In the territories closer to the sea and with lower continentality index with value 22 the shifting occurs sooner contrary to the territories which are far from the sea and are located where the value of continentality index is higher with value 31.

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Lake ice time series and climate variations

Matti Leppäranta

Department of Physics, University of Helsinki, P.O. Box 48, FIN-00014 Helsinki, Finland,
e-mail: matti.lepparanta@helsinki.fi

Lake ice phenology time series have been collected since 1800s. These time series consist of the dates of freezing and ice breakup and the number of ice days. The freezing date has been defined either as the date of the first appearance of ice or as the first complete freezing of the lake, while ice breakup refers to the first day after the disappearance of the ice in spring. In addition to phenology, the thicknesses of ice and snow have been recorded in many sites and their annual maxima serve as additional lake ice season statistics. Several investigations have been made on lake ice time series and their statistical properties have been interpreted for climate variations. In general, most of these time series show trends toward milder climate in the last 100 years superposed on aperiodic variations and noise.

This presentation analyses a set of selected time series from Finnish lakes and discusses the physical interpretation of lake ice phenology and the growth and decay of ice. The results provide tools for understanding the variations in the past lake seasons and making projections into the future. The thermal memory of lakes is less than six months, and therefore consequent ice seasons are independent. The freezing date is a complex function of fall air temperature evolution with correlation time scale depending on the lake depth. Ice growth depends primarily on air temperature and snow accumulation. Ice breakup is the most difficult case for physical interpretation. It depends on the maximum ice and snow thicknesses, solar radiation and air temperature; the onset of melting is the primary question to be solved.

In the present climatic conditions in Finland, warmer climate would bring significant qualitative changes to lake ice seasons. In particular, southern Finland would be part of the ephemeral lake ice zone where lakes do not free over every year and also open and frozen phases could appear several times in a winter. Also, thinner ice would block both on-ice and in-water traffic out of the lakes for much longer periods than presently.

Comparison of the trends and multi-time scale precipitation variability in Indian region derived from TRMM, WFD and rain gauge dataset

Lu Li[1], Chong-Yu Xu[1,2] and Zengxin Zhang[3]

[1]Department of Geosciences, University of Oslo, Oslo, Norway, e-mail: lu.lli@geo.uio.no
[2]Department of Earth Sciences, Uppsala University, Sweden, e-mail: c.y.xu@geo.uio.no
[3]Jiangsu Key Laboratory of Forestry Ecological Engineering, Nanjing Forestry University, Nanjing 210037, e-mail: njzhangz@gmail.com

During past two decades, numerous datasets have been developed for global/regional hydrological assessment and modeling, but these datasets often show differences in their spatial and temporal distributions of precipitation, which is one of the most critical input variables in global/regional hydrological modeling. This paper aimed to compare the consistency and difference of two widely used global precipitation datasets in India, i.e., Tropical Rainfall Measuring Mission (TRMM) and the Water and Global Change (WATCH) Forcing Data (WFD) and also to examine whether the pattern of seasonal (winter, pre-monsoon and monsoon) rainfall over selected region of India derived from reanalysis datasets and rain gauge records from Indian Institute of Tropical Meteorology (IITM) agree well enough for the reanalysis data to be useful in rainfall variability analyses or extending records of the gauge data in hydrological modelling, when rain gauge records are spatially sparse or temporally short. The study was carried out in the following steps. Firstly, the spatial–temporal distribution of TRMM and WFD precipitation in India was compared by using four statistical analysis methods, which include Mann-Kendall method for testing whether these two datasets reveal the same temporal variability as gauging dataset, Kolmogorov-Smirnov test for testing whether these two datasets follow the same distribution pattern, and T and F test for testing whether they have the same mean and variances with those of gauging data. Secondly, compare the pattern of pre-monsoon and monsoon rainfall over North Mountainous India (NMI), Northwest India (NWI), North Central India (NCI), West Peninsular India (WPI) and East Peninsular India (EPI) derived from reanalysis and rain gauge records. Furthermore, based on the wavelet transformation method, the multi-time scale of rainfall in India will be analyzed using TRMM and WFD. In every step, emphasizes were paid on the discussion of the consistency and difference resulted from using the two global datasets and gauging data. The approaches and results presented in this study contribute to the literature study of rainfall variability and the characteristic of reanalysis datasets.

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Parameter uncertainty analysis for a numerical model in Yanqi Basin

Li Ning[1,2], W. Kinzelbach[1], D. Mclaughlin[3],Li Wenpeng[2,4] and Dong Xinguang[5]

[1]IfU ETH Zurich, Switzerland, e-mail:ning.li@ifu.baug.ethz.ch,
[2]CIGEM, Beijing China,
[3]DCEE, MIT, Cambridge, MA 02139, U.S.A.
[4]Center for HEG, CGS, Hebei China,
[5]Dept. of Water Affairs, Xinjiang, China

The semi-arid Yanqi Basin is located in Xinjiang Province, China. The region which is characterized by scarce precipitation and high evaporation includes one of the biggest inland fresh water bodies in China—Bostan Lake. Due to the agricultural development and urban expansion in the past decades, the water resources management in Yanqi Basin faces challenges concerning both water quality and quantity. To better understand the mutual interaction between different hydrological processes, a distributed numerical flow and transport model has been set up and calibrated. It is based on the Software mikeshe/mike11 and includes rivers, unsaturated zone and aquifers. In principle the distributed simulation can provide instructive information on the water resources management for the decision makers. However, reliable advice can only be given, if the uncertainty of the model is quantified. This study focuses on the analysis of parameter uncertainty and its consequence for model predictions. The model structure is not questioned. As already a single model simulation is expensive in terms of computation time, the traditional Monte Carlo simulation for the uncertainty analysis is not feasible. Instead data assimilation by the Ensemble Kalman Filter method is adopted to update the parameters and their covariance time step by time step according to the observations. Different from traditional applications of the method the model states are not updated.

Recently, the ensemble square root filter has shown to be the preferred choice of most researchers. It is an ensemble filter expressed by the ensemble mean and the ensemble perturbation, but it avoids the perturbation of the observations. Here we will follow Livings's theorems and modify Envensen's square root filter to an unbiased square root filter which will preserve the mean of the parameters during the update process (Evensen G. 2004 and Livings M.D. etal 2008). For the flow and transport numerical model of Yanqi Basin, analysis focuses on the hydraulic conductivities, the drainage channels' leakage factor, the rivers' leakage factor, the van Genuchten parameters of the unsaturated zone, and the dispersion coefficients mainly. Based on the calibrated values of the parameters, 100 ensembles for each parameter are generated according to a normal, log-normal or uniform distribution. The observation time series of drainage flux to lake, river discharge, lake level, lake TDS, salt mass flux from river to lake, and salt drainage flux over the period 1980 to 2008 are chosen to update the parameters every time step. To keep the square root filter working well, the initial conditions of the groundwater levels in the saturated zone and the soil moisture in the unsaturated zone are perturbed after each time step. The results show that the uncertainty of the parameters is narrowed during the updating process because of the information from the observations. The covariance matrix of the parameters shows considerable correlation between parameters. The results of this study will be the basis for the analysis of model predictions and their uncertainty for various management scenarios envisaged.

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Evaluation of Long-term Discharge in Swedish Rivers - In search for Decadal Oscillations and the Relation to Known Climate Patterns

Angelica Lidén[1], Karin Persson[1], Kean Foster[1,2] and Cintia B. Uvo[1]

[1]Dept. Water Resources Engineering, Lund University, Box 118, 221 00 Lund, Sweden, e-mail: cintia.uvo@tvrl.lth.se
[2]Swedish Meteorological and Hydrological Institute, S-601 76 Norrköping, Sweden, e-mail: kean.foster@smhi.se

This work aims the qualitative and quantitative evaluation of river discharge variability in a long-term perspective. Through studying river discharge measurements from more than 100 stations in Sweden with between 50 and 100 years of data. Possible decadal oscillations are examined and the relation between the river flow long-term variability and known climatic patterns are sought.

Discharge data provided by the Swedish Meteorological and Hydrological Institute (SMHI) are selected from criteria of low regulation, long measurement time period and spatial distribution. Using wavelet analysis, the time series is converted into a time-frequency space, where oscillation patterns can be visualized. In order to find different zones of similar climatic dependency, station data are grouped depending similarity of oscillation periods.

Results are intended to be used for predictions and support of long-term decision making.

The Effect of Clear-Cutting and Energy Wood Harvesting on the Nitrate Leaching from two Spruce Stands in Southern Finland

Antti-Jussi Lindroos, Pekka Tamminen and Hannu Ilvesniemi

Finnish Forest Research Institute, P.O. Box 18, FI-01301 Vantaa, Finland

There has been an increasing interest for utilization of forest bioenergy during the last years. Considerable amounts of nutrients are removed from forest ecosystems when logging residues are harvested, because logging residues, especially needles, contain large amounts of nutrients. Nitrate leaching after clear-cutting is probably affected by logging residues, so that lower nitrate leaching may be related to the removal of logging residues. The aim of this study was to investigate the effects of logging residues on nitrate leaching in two clear-cut Norway spruce stands in southern Finland. This work is a part of the research programme "Bioenergy from forests" carried out in the Finnish Forest Research Institute.

Nitrate leaching was studied in two spruce stands located on glaciofluvial sandy soils. Clear-cutting was done in 2008, and the leaching experiments were started in the following year. Soil percolation water was collected during 2009-2011 from the small experimental sample plots, 1 m^2 in size. The treatments studied were 1) no logging residues, 2) 10 kg/m^2 of fresh spruce branches and needles, and 3) 40 kg/m^2 of fresh spruce branches and needles. Percolation water was collected at a depth of 40 cm below the ground surface. Percolation water was collected by means of plastic cover inserted into the soil around the studied soil profiles. Water samples were collected during the snow-free period at 4-6 week intervals. NO_3-N concentrations were determined by ion chromatography.

The highest NO_3-N leaching was associated with the highest amount of logging residues (40 kg/m^2) left on the site. Leaching was high even at the end of 2011, three years after the experiment started. The NO_3-N leaching was also higher in the logging residue treatment 10 kg/m^2 compared to the treatment without any logging residues. The NO_3-N leaching decreased clearly (<1 mg/l) in the third year of the experiment in the treatments 0 and 10 kg/m^2 logging residues. The results were comparable in the two study areas.

Modelling the effects of pumped water in a shallow multi-problem lake

Ninni Liukko[1] and Kati Martinmäki[2]

[1]Finnish Environment Institute (SYKE), Survontie 9, FI-40500 Jyväskylä, Finland, e-mail: ninni.liukko@environment.fi
[2]Finnish Environment Institute (SYKE), P.O.Box 413, FI-90014 Oulun yliopisto, Finland, e-mail: kati.martinmaki@environment.fi

Lake Pyykösjärvi is a small and shallow lake in the city of Oulu in Finland. The lake is eutrophied and occasionally faces very high nutrient concentrations. Algae blooms in the summer time and oxygen deficiency in the winter time have been observed in the lake. There are large amounts of organic matter transported from the catchment area in the lake sediment, whose depth is in some places more than two meters. Also a remarkable collapse in pH value has occurred in the lake water two times, in 2005 and 2010. As a management action, external water from River Oulujoki has been started to pump into the lake in 2010.

Lake Pyykösjärvi has a maximum depth of 2.4 m. The length of the lake is about 2 km and the width is 0.8 km. Lake Pyykösjärvi gets its water from couple of small trenches and during flooding times water is also entering to the lake sometimes from Stream Ruskonoja. Lake water is flowing out from the eastern end of the lake. Nutrient loading to the lake is coming from urban runoff, atmospheric fallout, birds and at times from Stream Ruskonoja.

The Coherens hydrodynamic model has been set up for Lake Pyykösjärvi within the PyyVesi ERDF (European Regional Development Fund) project. The model has a grid size of 25m*25m in the horizontal direction and it has 4 depth layers. Wind forcing used in the model is from a local weather station near the lake. The first simulations show that the current field in Lake Pyykösjärvi is formed like expected for a shallow lake: two eddies are formed and the water flows in the same direction as wind near the shores and towards the wind direction in the middle of the lake. However, the drogue measurements carried out in the lake in autumn 2010 and summer 2011 show opposite current directions in the middle of the lake. One of the measurements also show a two-layer current occurring in the lake. Because of this, an effort has been put to study the reason for the different current directions between the simulations and the drogue measurements. Possible reasons considered are for example wind shading, erronous depth or wind data, two-layer currents occurring in the lake for some reason and the massive macrophyte vegetation occurring in the lake at summer time.

During the summer 2012 an ecological sub-model will be applied to the top of the hydrodynamic Coherens model. Simulations are planned to be run in the situation of summer 2010 and in a scenario in which external water from River Oulujoki is pumped to the lake in two points in the middle of the lake. The results will be used in further planning of the pumping of external water.

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Buoy-based vertical profiler reveals dynamics of processes

Olli Loisa, Piia Leskinen and Juha Kääriä

Turku University of Applied Sciences, Department of Technology, Environment and Business
Sepänkatu 1, Fin-20700 Turku, Finland, olli.loisa@turkuamk.fi

Continuous water quality monitoring methods have developed quickly during recent years and a wide selection of devices for monitoring different water quality parameters is now available. The usability and reliability of these devices have already reached a good level and they provide new possibilities for researchers carrying out limnological and oceanographical studies.

We have tested since 2006 a buoy-based vertical profiler (YSI 6952), which allows fully-automated collection of water quality data from the whole water column. The profiler has been situated in the SW Finland in the Archipelago Sea. Analysis data of several different water quality parameters (e.g. temperature, salinity, turbidity and oxygen and chlorophyll concentration) is collected four times a day from the water column, from water depths 2-45 m at one meter intervals. The system is powered with solar panels and equipped with a programmable sampling winch and a 6000-series YSI multiparameter water quality sonde. Data is transferred to the laboratory via a GSM-datalogger. In the season 2011 some water quality parameters were presented near real-time to the public on the web portal of project BalticSeaNow.info.

Due to remote data delivery we have been able to follow dynamic hydrological and biogeochemical processes in detail: for example properties of different depth layers during stratification, the speed and development of autumnal mixing and the seasonal succession and vertical positioning of phytoplankton. Results of our *in situ* –measurements corresponded well to the results from the nearby long-term intensive monitoring site, where traditional standard sampling methods were used.

Even if the investment cost for this kind of instruments is on the expensive side, the operating costs have been relatively low. The need of technical on-site maintenance has been quite small and remote data delivery further reduces the need for costly field trips. However, the massive amount of data produced requires large resources for data handling and quality control. On the basis of six year of experience, the buoy-based vertical water quality profiler has proven to be reliable and practical tool when accurate information about fine-scale dynamics of water column processes is needed.

Fluvial processes and their future magnitudes: combined field observation and simulation approaches

Eliisa Lotsari[1]

[1]Department of Geography and Geology, FI-20014 University of Turku, Finland, e-mail: eslots@utu.fi

Discharges and intensity of erosion have been forecast to change by the end of 21st century due to climatic warming, but contradictory European scale studies of climate change impacts on discharges exist. These possible future discharge changes, but also changes in morphodynamics, should be taken into account when assessing flood risk. There has also been debate of the relative importance of different magnitude discharge events as channel modifiers and sediment transport agents. Therefore, further studies of climate change impacts on discharges, flood inundation and flow characteristics (velocity, shear stress and stream power), and morphodynamics are still needed.

The aim is first of all to 1) to derive more knowledge of present fluvial transport and channel evolution during frequent and infrequent discharges in different rivers. 2) It is also demonstrated the possible future discharge changes in different rivers and seasons (spring = March–May, summer = June–August, autumn = September–November, winter = December–February) on a century timescale. In addition, 3) discharge and sea level change impacts on flood inundation are analysed, and 4) estimates of the future changes in velocity, shear stress and stream power within and between different river reaches are made. Finally, 5) it is aimed to improve our understanding of the effects of possible discharge and sea level changes, and the relative importance of different magnitude discharges, on river morphodynamics. Several climate scenarios and hydrological simulation results are applied in numerical hydro- and morphodynamic simulations, supported by extensive field observations in 2007–2010. A national scale assessment of future runoff is produced for Finland, and case studies are conducted in two rivers representing different hydrological and geomorphological conditions: A) sub-arctic, sandy and braided lower Tana River (northern Norway), B) lower Kokemäenjoki River (coastal area of south-west Finland), whose channel consist mainly of cohesive sediments. Comparisons are made between these different river reaches.

The importance of fluvial transport and channel modifications during frequent discharges is emphasized in rivers consisting of either sandy or cohesive material. The future discharge changes are shown to vary greatly between these different rivers, and inundation extents are predicted to change non-linearly with discharge and sea level. Future changes in Flow characteristics (velocity, bed and boundary shear stress and stream power) and future erosion-sedimentation potential follow also the discharge changes, but variations within and between reaches need to be taken into account in future planning and flood risk assessments. The importance of discharges on river morphodynamics during other than spring snow-melt season is anticipated to increase on a century time scale, and the sea level change is expected to effect inversally to morphodynamics in river reaches bounded by the sea.

Impacts of climate change on groundwater resources in Hanko coastal aquifer, south Finland

Samrit Luoma, Birgitta Backman and Johannes Klein

Geological Survey of Finland (GTK), P.O. Box 96, FIN-02151, Espoo, Finland,
e-mail: samrit.luoma@gtk.fi

Shallow groundwater is an important local drinking water resource for Hanko town and the local industry. The Hanko peninsula's glaciofluvial aquifer is sensitive to climate change because the groundwater table is close to the ground surface, the aquifer extends to the sea shore, and water pumping levels are below sea water level. In order to safeguard future water supply and groundwater resources management, a comprehensive understanding of the hydrogeology and groundwater flow system of the aquifer is needed. Three-dimensional finite different groundwater flow models both, steady-state and transient, implemented in MODFLOW were constructed to assess the impacts of climate change on aquifer in different future climate scenarios CLM-A1B and -B1, and the sea level CLIMber-A1B, B1, and A1FI.

During the past 48 years (1963-2010) temperature and precipitation show the increasing trends (with the rates of 0.0419 ºC/year and 0.0054 mm/year) for the mean temperature and mean precipitation, respectively. Sea level trend contains high uncertainties; however a 40-year (1971-2010) trend analysis using the Mann-Kendall and Sen's non-parametric tests indicates a decreasing trend with rate of -1.33 mm/year.

By the end of 21th century, the mean temperature would increase between 1.3 - 3.4 ºC and the mean precipitation between 5 - 12 %. Seasonally, both temperature and precipitation would increase remarkably in autumn and winter (up to 4.6 ºC and 26 %). In summer, the temperature would slightly increase (2.6 to 2.9 ºC), but the precipitation would decrease (-2 to -5 %). Sea level would increase 22 to 81 cm from the current sea level, depending on scenarios.

Simulated groundwater modelling of the current situation shows a good balance of the water budget in the Hanko area. However a higher groundwater level is expected in autumn and winter based on the scenarios data. This could affect the water quality negatively if the groundwater rises closer to the ground surface. Groundwater level of observation tubes nearby the water work along the coastline correlate well with the sea water level but also with pumping rates. Although the Baltic Sea water in the Gulf of Finland area contains low salinity and has a low treat to groundwater resources, over-pumping or storm surge can cause risk to groundwater and water supply system.

The results of this study will provide useful information for the local authorities for regulating activities and groundwater management of the Hanko aquifer in the long term. This study was a case study area of the BaltCICA Project (Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region) that was part-financed by the European Union Baltic Sea Region Programme 2007-2013.

Capability of regulated small streams for nutrient retention in the dry season

Jelena Lysovienė[1] and Valerijus Gasiūnas[2]

Water Research Institute, Water and Land Management Faculty, Aleksandras Stulginskis University, Parko 6, Vilainiai, LT-58102, Kedainiai district, Lithuania,
e-mail: [1]j.lysoviene@gmail.com, [2]v.gasiunas@water.omnitel.net

Streaming water is capable of self-purification from the influx of pollutants depending on various physical, chemical and biological factors. The objective of this work was the evaluation of nutrient retention factors and their dependencies in small regulated streams artificially changed by straightening their channels. The main task was to determine the existence of significant relations between nutrient retention in the water of regulated streams and physico-chemical parameters under investigation what allow forecasting the water quality.

In the dry season of 2010 – 2011 (from June to October) 5 ranges of regulated streams with a maximum distance of 8.6 km to the pollution source below the settlements of less than 2000 inhabitants were measured for evaluation of nutrient retention dependence on various factors. Streams under investigation are located in the river Nevėžis basin in the Middle Lithuania which is characterized by low absolute heights (to 80 – 90 m) and urbanized landscapes intensively used for agriculture and stockbreeding. They are attributed to the same geographical zone with similarities in soil, geological conditions and hydrological regime.

The discharge of investigated streams in the analyzed time period fluctuated from 0.0003 to 0.27 m3s-1 with respect to their size. Different factors in the process of self - purification downstream the pollution source were measured and evaluated. After the statistical analysis was carried out, the most influential factors affecting the decrease of nutrients appeared to be water discharge, temperature and load from the pollution source.

With the impact of factors evaluated, the following dependencies of stream water load with certain pollutants could be observed:

total P y=153.2-59.3 x1+4811.4 x2+0.89 x4
total N y=22713.4+385498 x2-1376.6 x3+0.41 x4

here: y – stream water load with pollutants, g d-1;
x1 – distance from the pollution source, km;
x2 – stream discharge, m3 s-1;
x3 – water temperature, 0C;
x4 – load from the pollution source, g d-1.

With the increasing distance from the pollution source, stream load with total P decreased. Nevertheless, it remained higher than the initial level measured above the settlement in every investigated stream range. The length of investigated ranges (up to 8.6 km) was insufficient to acquire reliable relationship between the changes of stream load with total N and the distance. Receding from the pollution source, nitrogen form in the water changes from ammonia to nitrate due to nitrification processes.

Demonstration of web based map service to integrate data and models for participatory river basin management

Olli Malve[1], Anita Etholen[1], Sanna Helttunen[3], Tuomo Kauranne[2], Matti Lindholm[1], Heikki Mäkinen[5], Timo Pyhälahti[1], Pasi Roti[2], Matti Silvennoinen[2], Vincent Westberg[4] and Sari Väisänen[1]

[1]Finnish Environment Institute, P.O. Box 140, 00251 Helsinki, Finland, e-mail: olli.malve@ymparisto.fi
[2]Arbonaut Oy Ltd, Koskikatu 5 b, 80100 Joensuu, Finland, e-mail: tuomo.kauranne@arbonaut.com
[3]The Association for Water and Environment of Western Uusimaa, Länsi-Louhenkatu 31, 08100, Lohja, Finland, e-mail: sanna.helttunen@luvy.fi
[4]Centre for Economic Development, Transport and Environment in South Ostrobotnia, Hovioikeudenpuistikko 19 A, 65101 Vaasa, Finland, e-mail: vincent.westberg@ely-keskus.fi
[5]Päijät-Hämeen Vesijärvisäätiö Foundation, Askonkatu 9 C, 15100 Lahti, Finland, e-mail: heikki.makinen@vesijarvi.fi

The state of the art of cost-efficient analysis and control of algal blooms in the planning and implementation of WFD programs of measures and in river basin management in general are based on fragmented and incompatible monitoring networks, databases, analysis and modeling tools, decision systems and dissemination protocols which are not optimal for the cost-efficient implementation of WFD. Improving the integration and complementary use of these elements increases considerably the cost-efficient utilization of this information in the river basin management.

The GISBLOOM project introduced, demonstrated and evaluated a web-based map service Vesinetti which include an array of technical and methodological innovations to improve the cost efficiency of participatory implementation of WFD and of river basin management.

By integrating available data and models into river basin management plans and by developing a participatory approach, the Vesinetti contributes to the achievement of the environmental objectives of the EU Water Framework Directive (2000/60/EC), the Marine Strategy Framework Directive (2008/56/EC) and the Nitrates Directive.

Vesinetti was designed to improve understanding of algal bloom and eutrophication responses to management measures and to climate change in lakes and coastal areas. It combines nationwide data and models on climate, hydrology, hydrobiology, land-use, management measures, nutrient loads and water quality responses. Based on data and models it provides real-time forecasts for algal blooming in river basins and around 48 000 Finnish lakes on a daily basis. Vesinetti was also aimed at facilitating participatory river basin management. This process will inform the selection of cost-efficient measures for river basin management plans in eight pilot areas. As a result, Vesinetti provides integrated, web-based tools and services for monitoring, ecological and cost-benefit analyses, forecasting and decision making. The demonstration in seven river basin management projects gave substantial feedback for the development of Vesinetti.

Comparison of river plume models – Case study of Rhone river

Akiko Mano[1] and Ninni Liukko[2]

[1]Ochanomizu University, 2-1-1, Ohtsuka, Bunkyo-ku, 112-8610, Tokyo, Japan,
e-mail: mano.akiko@ocha.ac.jp
[2]Finnish Environment Institute (SYKE), Survontie 9, FI-40500 Jyväskylä, Finland, e-mail:
Ninni.Liukko@ymparisto.fi

The aim of this study is the comparison of three hydrodynamic models in the case of Rhone River plume. Climatology and freshwater inflow are considered as the current driven forces. The results are compared with the impact of these forces on plume behaviour. In these processes, the differences among the models were found out and the most suitable model for the Rhone River plume was chosen.

Nowadays, a number of models are developed by a number of projects. Each of them, however, has advantages and disadvantages for a certain aspect because the schemes or numerical techniques are applied differently. This is because the model to calculate the natural environment system such as water circulation of the lake or the sea need to consider its scale of phenomenon as suitable for the study region.

In this study we carried out a comparison to choose the most suitable model to reproduce the Rhone River plume advection. The idea is to implement satellite data assimilation for model validation. We compared the results of three models: COHERENS Version 1(V1); COHERENS Version 2(V2); a model developed by Mano(2011)(MM), which is already validated for the Rhone River plume behaviour under the regional specific wind conditions. V2 is not released officially. Thus this study can also be a test material to develop V2.

The judgment is based on data of Suspended Particle Matters(SPM) derived from MODIS satellite sensor from years 2003 to 2009 according to climatology and river discharge. At the end, V2 was judged as the most suitable model to reproduce the Rhone River plume for the aspect of the wide range of calculation feasibility and the correspondence of plume surface area with SPM distribution from satellite images.

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Better biological monitoring methods to evaluate effect of peatland land uses on watercourses?

Hannu Marttila[1], Satu-Maaria Karjalainen[2], Mika Nieminen[3], Kristian Meissner[3], Anna-Kaisa Ronkanen[1], Minna Kuoppala[2], Mika Visuri[2], Seppo Hellsten[2] and Björn Klöve[2]

[1] University of Oulu, P.O. Box 7300, FIN-90014 Oulun yliopisto, Finland, e-mail: hannu.marttila@oulu.fi
[2] Finnish Environment Institute, Oulu Office, P.O.Box 413, FI-90014, University of Oulu, Finland, e-mail: satu.maaria.karjalainen@ymparisto.fi
[3] Finnish Environment Institute, PO Box 35, 40014 University of Jyväskylä, Finland

Peatland land uses, such as peat mining and peatland forestry, are commonly located in headwater areas which naturally have flashy hydrographs and rapid changes in water quality. In these conditions, traditional water sampling using physical-chemical monitoring does not reliable represent the status of watercourses or load transported from land uses. Instead different biological indicators reflect long term changes in water quality, and thus would give better image from possible changes. To address this problem, new joint research project (BioTar) between Finnish Environment Institute and University of Oulu was established 2011. Herein, we use recent advantages in biological methods and sediment measurements to exploit and improve assessment of peat land uses to water quality status. Specifically, we test suitability of different biological methods such as CPET, diatoms and moss at soft organic beds conditions and different physical and geochemical methods for sedimentation studies. We hypothesis that we can find suitable biological method for headwater conditions, which represent changes in soft organic beds and further link sediment properties to biological indicators. For this purposes totally 60 headwater channels are sampled with categories of i) natural headwaters, ii) peat mining and iii) peatland forestry. The results enable parameterization of biological indicators to monitor peatland land use practises, and further, sedimentation and transport conditions in headwater conditions.

Key words peatland, drainage, biological indicators, organic sediment

Can temporal detention of runoff water be used as water protection method in peatland forestry?

Hannu Marttila[1], Kari-Matti Vuori[2], Hannu Hökkä[3], Juha Jämsen[4] and Bjørn Kløve[1]

[1]Water Resources and Environmental Engineering Laboratory, Department of Process and Environmental Engineering, 90014 University of Oulu, Finland,
e-mail: hannu.marttila@oulu.fi
[2] Finnish Environment Institute, PO Box 35, 40014 Jyväskylän yliopisto, Finland
[3]Finnish Forest Research Institute, Rovaniemi Research Unit, Eteläranta 55, 96300 Rovaniemi, Finland
[4]Central Finland Forestry Centre, Pihtipudas Office, PL 11, 44801 Pihtipudas, Finland

At peatland forestry conditions, a major part of the pollutant load is transported during peak runoff periods after snowmelt or intense rainfall. In these conditions, traditional water protection methods often fail to serve properly. This presentation (oral) represent possibilities to increase retention time of runoff waters in drained peatland catchments on purpose to diminish peak runoff and improve settling conditions of suspended solids (SS). To create retention, a peak runoff control (PRC) structure was developed and its functioning, dimensioning and practical applications were studied in seven partly or completely ditch-drained catchments in Central Finland. Also erosion and sediment transport processes were studied. Results clearly indicate that effective water quality management in drained peatland areas can be achieved using the PRC method in drainage areas. The main effect of PRC is on SS and SS-bound nutrients. Different issues relating to the sediment transport dynamics, structural design, water quality benefits, and impacts on forestry are discussed.

Investigation of stream temperature response to nonuniform groundwater discharge in a Danish lowland stream

Karthikeyan Matheswaran[1], Morten Blemmer[1], Paul Thorn[1], Dan Rosbjerg[2] and Eva Boegh[1]

[1] Dept. of Environmental, Social and Spatial Change, Roskilde University, PO Box 260, 4000 Roskilde, Denmark, e-mail: karthi@ruc.dk
[2] Technical University of Denmark (DTU), Miljoevej, Building 113, 2800 Lyngby, Denmark, e-mail: daro@env.dtu.dk

Nonuniform groundwater discharge influenced by geomorphologic and hydrogeological settings at regional and local scales control numerous characteristics governing the lotic ecosystem. Stream temperature is one of the vital characteristics, and is influenced heavily by the thermal influence of groundwater discharge particularly during low flows. This affects adjacent riparian and riverine ecological processes. This study focuses on the influence of nonuniform groundwater discharge on temperature of a Danish lowland stream using a Distributed Temperature Sensing (DTS) system (Selker et al., 2006) and a stream temperature model in three distinct measuring periods. An Agilent DTS unit (N4386A) with 1.8 km multimode fiber optic cable was installed longitudinally along the streambed in Stream Elverdamsåen, Denmark, to collect high resolution spatial and temporal temperature data to locate groundwater discharge zones.

The resultant stream temperature data from DTS within the study reach revealed presence of 16 anomalies in August and November 2010, and 19 anomalies in May 2011, indicating the presence of groundwater discharge zones. Of all the identified groundwater discharge locations, only four anomalies, located at 1093 m, 1201 m, 1412 m and 1515 m from reach start, were present in all three measurement periods. The locations of other groundwater discharge zones were found to be highly dynamic due to complex heterogeneity of the shallow groundwater system in the Danish Weichselian moraine landscape.

A one-dimensional stream temperature model (Boyd et al., 2003) was used to simulate longitudinal stream temperature for the three measuring periods, within which temperature and groundwater discharge locations derived from DTS data were used as inputs. The stream temperature simulated in three scenarios reflects the observed patterns, particularly in August 2010 and May 2011 scenarios when discrete inflows of colder groundwater at 16 and 19 locations respectively were quantified and represented in the model. Comparison of simulated stream temperature with and without the distributed longitudinal inflow sources predicted overall dampening of temperature and made a strong case to consider non-uniform groundwater inflow as a major factor regulating overall stream temperature in the study reach. The high flow conditions in November 2010 made the model relatively insensitive to the warmer groundwater influx. Combined use of DTS and stream temperature model has led to improved understanding of spatially and seasonally varying groundwater discharge and its influence on stream temperature.

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Flash floods trend detection in Lithuanian rivers

Diana Meilutytė-Barauskienė and Diana Šarauskienė

Laboratory of Hydrology, Lithuanian Energy Institute, Breslaujos g. 3, LT-44403 Kaunas, Lithuania, e-mail: diana@mail.lei.lt

Flash flood is a period when during a river drought time water discharge suddenly increases and exceeds the annual average discharge. Flash flood is a sudden local flood of great volume and short duration which follows a few (usually less than six) hours of heavy or excessive rainfall, or due to dam or levee failure, or the sudden release of water impounded by an ice log jam.

Flash floods are a serious problem in the Mediterranean region in particular, and in Europe in general. In Central and Eastern Europe, flash floods are a phenomenon that takes place in small regions, characterized by limited spatial extent, and this is why the damage they cause can best be limited on the local level.

In Lithuania increasing river water level during flash floods brings a lot of problems as well. According to the data of Lithuanian Hydrometeorological Service in 2005 2.5 – 3 times bigger than the mean annual amount of precipitation fell in the western and southeastern parts of Lithuania. Heavy rain caused the Merkys River (in the southeastern part of Lithuania), its tributaries and the Minija River (in the western part of Lithuania) to overflow. In July of 2007, very sudden and great flash flood occurred in the western part of Lithuania. The amount of precipitation was three times higher than a monthly rate). The rivers could not handle that big amount of rain water, the water level reached catastrophic level and overflowed.

The hydrological regime of the Lithuanian rivers depends not only on climatic factors, but also on geomorphology, geology, type of land use and soil structure. Depending on the hydrological regime, rivers in Lithuania are grouped into 3 major types – western, central and southeastern. A marine type of climate prevails in the western region characterized by the largest amount of precipitation, the highest winter temperature and the least number of days with snow cover. A very irregular discharge distribution during a year is the main feature of the rivers in central Lithuania. A continental type of climate is typical for southeastern Lithuania where the snow-cover duration is the longest, and winters are the coldest. Regionalization of the country territory is necessary for description of precipitation, temperature and river runoff patterns.

The main task of this study was to investigate variability of flash flood data in Lithuania using trend detection (Mann–Kendall and Spearman–Rho). Comparison of two time periods (1920-2008 and 1991-2008) with data of the reference period (1961-1990) was performed.

The investigation covered the flash flood data (32 water measurement stations) of 3 hydrological regions: western, central and southeastern. Flash floods of the warm and cold (from the beginning of winter till spring flood) periods of a year were evaluated separately.

The results obtained indicate the substantial difference of flash flood fluctuation tendencies in different regions of Lithuania and different studied time periods. The study showed that flash flood is the most characteristic for the rivers of western Lithuania.

Keywords: flash flood, hydrological time series, trend

Challenges for hydrological research in cold, semi-arid environments: case study Northern Mongolia

Lucas Menzel[1], Benjamin Kopp[1], Stefanie Minderlein[1]

[1]Department of Geography, Heidelberg University, Im Neuenheimer Feld 348, D-69120 Heidelberg, Germany, e-mail: lucas.menzel@geog.uni-heidelberg.de

Mongolia is facing a large number of water-related problems, such as adverse natural conditions (extremely continental climate, low precipitation totals), increasing water withdrawals and a lack of structures which control the appropriate distribution and protection of water. Within the project "Integrated Water Resources Management in Central Asia – Model Region Mongolia (MoMo)" (http://www.iwrm-momo.de/) a large number of Mongolian and German researchers and practitioners collaborate in the fields of hydrology and climatology, water resources and land management as well as urban water and wastewater treatment. The overall aim of MoMo is to establish an example of a system of Integrated Water Resources Management (IWRM) in the Kharaa basin (ca. 14,500 km²) in northern Mongolia. The largest city within the catchment is Darkhan (approx 140,000 inhabitants) which is very much reliant on groundwater fed by the Kharaa river. The headwaters of the Kharaa are located in the Khentii Mountains which stretch in the east of the catchment and peak at about 2800 m a.s.l.

For a better understanding of the climatic characteristics and the freshwater generating processes and in order to extend the scarce, water-related information, a monitoring programme to study relevant hydrological, hydrometeorological and ecological processes was established in the Sugnugur valley in the remote headwater regions of the Kharaa. The investigations aim at improving our knowledge about the spatio-temporal variations of water availability in a semi-arid environment as well as the impacts of environmental change on hydrological processes and water resources. The Sugnugur was selected as a research basin since it is situated in the transition belt between the taiga and steppe zones and therefore includes a variety of environmental factors, e.g. snow storage, permafrost occurrence or forest distribution which determine hydrological processes, water quality and water availability. Parts of the region represent a pristine boreal and mountain environment. It is assumed that they act as the major freshwater generating areas of the Kharaa catchment. However, there are several indicators of direct and indirect human impacts on the ecosystem (e.g., human-caused forest fires, leaving extensive areas with burned forest) which will undoubtedly have consequences for water retention in the headwaters and thus water availability in the dry steppe zone.

Beside the hydro-meteorological research programme two hydrological models of different complexity are applied in order to compute the individual water balance components and to assess water availability for human water use over the entire Kharaa basin. The models are driven by standard meteorological observation data and auxiliary information from the projects' monitoring programme. Some components of the models (e.g., the evapotranspiration and soil modules) will be further developed based on knowledge from the field investigations.

The presentation will describe the water-related problems of Mongolia and presents first results from the field and simulation experiments.

Long-term trend analysis of the extreme annual discharge series OF THE Danube during the period 1876–2005

Pavol Miklanek[1], Pavla Pekarova[1], Jan Pekar[2] and Peter Skoda[3]

[1]Institute of Hydrology Slovak Academy of Sciences, Racianska 75, 831 02 Bratislava, Slovakia, e-mail: miklanek@uh.savba.sk
[2]Dept. of Applied Mathematics and Statistics, FMPI Comenius University, Bratislava, Slovakia
[3]Slovak Hydrometeorological Institute, Bratislava, Slovakia

The Danube River Basin is Europe's second largest river basin, with a total area of 817,000 km². It is the world's most international river basin. In January 2008 Danube basin included the territories of 19 countries. Its river basin is situated between the headwater regions of the Rhine and the Dnieper River. The Danube River has a total length of 2,857 km. About one third of the Danube River basin is mountainous. The average altitude of the Danube catchment is 475 m a.s.l. The Tisza River Basin is the largest sub-basin in the basin (157,186 km^2). It is also the Danube's longest tributary (966 km). By flow volume, it is the second largest after the Sava River. The Sava River is the largest Danube tributary by discharge (average 1,564 m^3s^{-1}) and the second largest by catchment area (95,419 km^2). The Inn is the third largest by discharge and the seventh longest Danube tributary.

The occurrence of the floods is analyzed the in the upper, central, and lower Danube basin based on archive data from the database of the project „Flood regime of rivers in the Danube River basin". In the first part, the propagation of the floods downstream the Danube river is analysed between the stations Berg and Ceatal Izmail based on maximum annual discharge series 1931–2005. In general, in the Danube river basin it holds, that periods around years 1915, 1940, 1965, and 1980 were extremely rich with runoff. In contrary, the period around 1947 and the nineties of the twentieth (last) century were extremely dry. But the period around the year 1863 was in the Danube river basin even drier. Therefore the trends determined from the years 1901–2005 or 1931–2005 cannot be considered conclusive.

The time series of the maximum annual discharge were used from 23 stations along the Danube. The floods in the upper and lower parts of the Danube basin do not occur in the same years necessarily. The high flows do not hit the whole area of the Danube basin. The floods occur most frequently in June-August in the upper Danube basin, in April in the central part, and in April-May in the lower

In the second part the long-term trends are discussed of the maximum annual dischrge series of the Danube. In the case of annual maximum discharge time series the period 1931–2005 is not representative. The final two decades at the end of the 19-th century were extremely rich on the catastrophic floods in the whole Danube basin. In the Upper Danube, the period 1900–1953 was poor on the floods. Since 1954, the variability of the floods is higher, and similar in comparison to period 1876–1899. Therefore the long-term trends we tested for period 1876–2005 for four stations along the Danube River, only. For the trend analysis we used the maximum annual discharge series of 1876–2005 in stations Linz, Stein-Krems/Kienstock, Bratislava and Orsova/Turnu Severin. The significant increasing trend was identified by Mann-Kendal test in station Linz in 1876–2005. The increase in Stein-Krems/Kienstock is less pronounced. The increasing trend was not confirmed in stations Bratislava and Orsova. Danube.

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Surface wastewater impact on the environment from pig-breeding enterprise production territory

Stefanija Miseviciene

Aleksandras Stulginskis University Water Research Institute, Parko g. 6, Vilainiai, 58102 Kedainiai district, Lithuania, e-mail: stefanija.miseviciene@asu.lt

In order to reduce pollution in the Baltic Sea, surface wastewater management is given a special attention in Lithuania in recent years. It is a topical issue, given that wastewater from stationary pollution sources contains many harmful substances such as petroleum products, heavy metals and biogenic substances, stimulating water eutrophication.

The biggest environmental problems in Lithuania are caused by 24 operating pig-breeding complexes with stock capacity higher than 5000, keeping 573 thousand pigs, 65 companys and pig farms with stock capacity higher than 200, keeping 77.0 thousand pigs, 2179 cow - cattle farms with stock capacity higher than 50, keeping 319.4 thousand cattle, and 21 poultry farms with stock capacity higher than 1000, keeping 9946.7 thousand fowls. The key reason is inadequate sewage treatment and poor technology.

Not surprisingly, environmental pollution increases significantly as a large amount of livestock is kept in one place. However, the most exceptional attention should be paid to polluted livestock buildings and farms, where manure is collected and stored, areas trampled and slurred by cattle convenient for wastewater formation, as well as areas damaged by mechanisms. Farms are generally lacking or do not have any wastewater treatment facilities; therefore untreated wastewater is released into the environment, contaminating it.

The 2007-2011 data is being analysed on the production territory surface wastewater quality of the pig-breeding enterprise.

The aim of the analysis is to examine the impact of the surface wastewater run-off from pig-breeding enterprise territory on the environment.

There is a positive relationship between surface wastewater contamination by organic compounds and suspended solids. Correlation analysis showed that a higher amount of suspended solids increased organic contamination in wastewater (r = 0.75). An increase in suspended solids and BOD_7 concentration in wastewater is related to a higher precipitation level: (r = 0.64) and (r = 0.62), respectively.

It was estimated that pig-breeding enterprise production territory average surface wastewater contamination by organic compounds (BOD_7) was low 5.6 mg $O_2 l^{-1}$. Other chemical elements' average 5-year study concentrations were low as well: suspended solids – 12.1, total nitrogen – 3.1, total phosphorus – 0.6, oil products – 0.7 mg l^{-1}.

The chemical elements' concentrations in the surface wastewater run-off from pig-breeding enterprises production territory were lower than the maximum allowable concentration (MAC). In 2008, after the reconstruction of the enterprise and the installation of wastewater treatment facility, a declining trend in chemical substances from the surface water of pig-breeding complex was observed: BOD_7 (r = 0.71), suspended solids (r = 0.58), total nitrogen (r = 0. 34), and total phosphorus (r = 0.34). Thus, it can be claimed that pig-breeding enterprises production areas surface wastewater impact on the environment is minimal, because the concentrations of tested chemical elements were lower than MAC.

Trends in evaporation in northwest region of Iran

Mohammad Mehdi Moayeri[1], Davood Farsadizadeh[2] and Hadi Sanikhani[3]

Water Engineering Department, Faculty of Agriculture, University of Tabriz, Iran,
e-mail: [1]mm100@ymail.com, [2]farsadi@tabrizu.ac.ir, [3]hadi.sanikhani@yahoo.com

In this study, trends of evaporation in the northwest region of Iran are evaluated for 15 stations which have 30 years of evaporation records. The trends are detected using three variation of Man-Kendall (MK) test. These variations include (1) Man-Kendall without autocorrelation (2) Man-Kendall with lag-1 autocorrelation and trend free-pre-whitening (3) Man-Kendall with complete autocorrelation. The slopes of trend lines were computed using Thial-Sen's slope estimator. Results showed that increasing trends were observed in evaporation of the northwest region of Iran.

Keywords: Evaporation, Northwest region of Iran, Man-Kendall, Thial-Sen's slope estimator

Snowmelt Modelling in Urban Areas Sensitivity Analysis of the Energy and Mass Balance Method

Shahab Moghadas, Camilla Westerlund, Anna-Maria Gustafsson and Maria Viklander

Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology, Sweden, e-mail: shahab.moghadas@ltu.se

Flooding is one of the main concerns in seeking safe and sustainable urban areas. In many cases the design criteria are based on intense rainfall. It is, therefore, assumed that the peak flow in cities' drainage systems is due to heavy and fast rainfalls. However snowmelt pattern could be more important for places with cold climate; therefore the need of a better snowmelt and runoff simulation becomes more important particularly when the effects of climate change needs to be considered.

Two main methods are basically used for urban snowmelt simulation i.e. temperature index and energy budged methods. Studies done previously show that the energy balance method gives a better estimation for volume and time compare to the temperature index. For urban areas though, it is argued that the data demanding of the energy balance method can be a disadvantage and it could affect the model precision. However, the advances in geographical information systems (GIS) and the requirement for better time resolution than daily have increased the tendency of applying it for urban snow melt. There are couples of studies during recent years e.g. (Ho& Valeo 2005) applying energy budget method in urban areas, even though the efforts basically focused on developing routines and comparing it with the degree day method. There is still a gap in parameter sensitivity analysis especially with two main features of urban snowmelt modeling; firstly, the importance of input data along with difficulties in providing them; and secondly the classification of snow in urban areas based on snow properties. These two concerns were the motives to go one step ahead and to conduct a sensitivity analysis. The aim of the study is therefore to investigate the dependency of the simulation results to the different model parameters as built-in parameters and input data. Such analysis eventually can be used for snow classification which along with GIS technology can provide a reliable platform to simulate snowmelt over an urban catchment more precisely than what the current models are capable of today.

Here in this study, a model namely Utah Energy Balance Snow Model (UEB) is used. The model uses a complete energy and mass balance routine to simulate snow accumulation and melt at a point scale. Except using the measured climatic values to run the model, the routines in this model has the capability of producing (simulating) solar radiation and albedo if the measured values are not available. The model has simulated the snow accumulation and melts in rural area with reasonable accuracy in previous studies i.e. (Tarboton et al. 1995).

For this research, three snow deposits from 1991 and 1992 are taken to calibrate the model with. The pilot snow packs are identical to municipal snow deposit with density more than natural snow, around 700 Kg/m^3. The snowmelt runoff has been measure between March and Jun 1991 and 1992. The necessary input values are collected from Meteorological and Hydrological Institute (SMHI) for the same periods. All input parameters are available on hourly and 3 hourly periods. The method is to run the model with real values collected from SMHI and calibrate it versus the measured data. The model is run using modified parameters to investigate the possible change in the simulation result. Eventually an analysis is done on each parameter and the dependency of the model. An analysis also is done by running the model with different time resolution, i.e. hourly, 3-hourly, and 6-hourly and to investigate the effect of time span in modeling snowmelt and simulation precision.

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Prediction of Concentration Time in Kasilian Watersheds by Using Geomorphologic Method

Reza Mohammadpour[1], Touraj Sabzevari[2] and Ali Torabi Haghighi[3]

[1]PHD candidate, River Engineering and Urban Drainage Research Centre (REDAC), Universiti Sains Malaysia, Engineering Campus, Seri Ampangan, 14300 Nibong Tebal, Penang, Malaysia, e-mail: reza564@gmail.com
[2]Department of civil engineering, Estahban Branch, Islamic Azad University, Estahban, Iran
[3]PhD candidate, Water resources and environmental engineering laboratory, University of Oulu, Finland

The response time of watersheds is main parameter of rainfall-runoff models which has a direct effect upon the flood estimation precision. Several equations were presented to estimation of concentration time in watersheds with different accuracy depends on the number of variable. In this study, two methods were introduced to forecast concentration time based on travel time computation in overland and channels. The first one is geomorphologic method and the second one, watershed Hortonian coefficients method. The Kasilian (Iran) was selected as a case study to validation of results. The concentration time obtained by the flood hydrograph as well as the rainfall hyetograph was used as observation data and comparison basis. The result of presented methods was compared with thirteen empirical equations using the HEC-HMS software. The result shows, the Geomorphologic method (hydrological notion) can predict the concentration time (T_C) with high accuracy (RMSE=0.69) in compare to other methods. The proposed Horton method with RMSE =1.43 has acceptable outcome and can be comparable with empirical equations.

Keywords: time of concentration (T_C), geomorphologic method, Kasilian watershed, Hortonian coefficients method

Influence of regional warming trends on lake water dissolved oxygen dynamics: A preliminary investigation in Lake Ikeda, Japan

Kazuro Momii[1] and Yuji Ito[2]

[1]Department of Environmental Sciences and Technology, Kagoshima University, 1-21-24, Korimoto, Kagoshima, 890-0065 Japan, e-mail: momii@agri.kagoshima-u.ac.jp
[2]Institute of Lowland and Marine Research Center, Saga University, 1 Honjo-machi, Saga, 840-8502 Japan, e-mail: sj7549@cc.saga-u.ac.jp

The effects of regional warming trends on lake water environmental variables have been studied all over the world because lakes integrate responses to climate change over time in different climatic regions (Adrian et al., 2009; Coats, 2010). In this study, the influence of warming trends on dissolved oxygen (DO) of Lake Ikeda, located in southern Japan, is investigated based on observations of air and water temperatures and DO during the period 1981-2011, and based on numerical simulation using a one-dimensional eddy diffusion type model (Momii and Ito, 2008). Observed data show that the annual mean air temperature and hypolimnetic water temperature for 1981-2011 increased at a rate of 0.032°C $year^{-1}$ and 0.030°C $year^{-1}$, respectively. Water temperature at a depth of 200m also gradually increased from 10.2°C in the 1980s to 11.0°C in 2011. Under this warming trend, a complete vertical mixing up to the lake bottom occurs only three times, in 1984, 1986 and 2011, which means that Lake Ikeda can be categorized as an oligomictic lake.

For 21 years from 1990 to 2010, the lake bottom was under anoxic condition because mixing was not complete. In the middle of February 2011, when the mean air temperature from January to February decreased by 8°C, the lowest since 1987, vertical mixing due to surface water cooling occurred and consequently a uniform vertical water temperature of 11°C and DO of about 4.5 mg L^{-1} were observed. After the mixing period, surface water temperature rose with solar radiation and thermal stratification grew. The epilimnetic DO then rapidly increased due to reaeration, while the hypolimnetic DO gradually decreased due to oxygen decomposition by biochemical oxygen demand (BOD) and sediment oxygen demand (SOD).

The lake water DO dynamics under the warming trends were numerically analyzed by the vertical one-dimensional heat and DO transport model referring to the local meteorological variables such as air temperature, wind speed, shortwave and longwave radiations. Preliminary results calculated by the model indicate that chlorophyll-a profile in the epilimnion, oxygen consumption rate by BOD in the hypolimnion, SOD, and vertical diffusion coefficient are the important site-specific parameters to reproduce the temporal and spatial changes in the lake water DO.

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Effects of different landuses on peat hydraulic properties

Pirkko Mustamo[1], Maarit Hyvärinen[1], Anna-Kaisa Ronkanen[1] and Bjørn Kløve[1]

[1]Water Resources and Environmental Engineering Laboratory, University of Oulu, P.O. Box 4300, FIN-90014 Oulun yliopisto, Finland, email: firstname.lastname@oulu.fi

Cultivated peatlands are a major source of CO_2 and N_2O emissions in Nordic countries (Kasimir-Klemedtsson et al., 1997). There is a need to manage these peatlands in a way that minimizes the GHG emissions, or to restore the hydrology of the sites while taking into account the potential negative effects such as phosphorus leaching. Thus, information about effects of landuse on peatland soil physical properties, including hydraulic conductivity and water retention properties, is needed. There is a great variation in peat hydraulic conductivity depending on soil depth and degree of decomposition (e.g. Letts et al., 2000), although relationship between hydraulic conductivity and humification of peat is not straightforward (e.g. Chason and Siegel, 1986). The aim of this study is to find out how physical properties of peat soils in different landuses vary and to produce new information, e.g., for modelling.

Study sites in Pelso peatland complex include peatland areas drained for forestry, agriculture and peat extraction and also an undrained bog. We collected undisturbed peat cores of known volume and also disturbed peat samples from four study sites in different landuses. Ash content, porosity and bulk density were measured from the samples, and also water potential curves were determined. Measurements of hydraulic conductivity were made *in situ* with infiltrometer (direct push piezometer) in six study sites (two undrained bogs, two sites drained for forestry, one site in agricultural use and one site drained for peat extraction).

Preliminary results show that hydraulic conductivity was lowest in the peat extraction site and the agricultural site. In both the agricultural site and the peat extraction site, bulk density in the top 75 cm of soil decreased and porosity increased with soil depth, whereas in the bog and forest differences between the layers in the top 75 cm of soil were not as clear. The greatest ash content and bulk density were found in the agricultural site due to the agricultural practice of adding sand to soil.

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Climate change and boreal rivers: Predicting present-day patterns and future changes in hydrological regime and its effects on river communities

Kaisa Mustonen[1], Heikki Mykrä[1], Timo Muotka[2] and Björn Klöve[3]

[1]Thule Institute, University of Oulu, P.O. Box 7300, 90014 Oulun yliopisto, Finland, e-mail: kaisa.mustonen@oulu.fi, heikki.mykra@oulu.fi
[2]Department of Biology, University of Oulu, P.O. Box 3000, 90014 Oulun yliopisto, Finland, e-mail: timo.muotka@oulu.fi
[3]Water Resources and Environmental Engineering Laboratory, University of Oulu, P.O. Box 4300, 90014 Oulun yliopisto, Finland, e-mail: bjorn.klove@oulu.fi

According to recent prediction scenarios the average global surface air temperature has been predicted to increase 0.2 °C a decade, adding up to a total of 2.0 degrees increase by the end of the 21th century. Future projections suggest that northern regions will experience a much faster climate warming compared to other regions, and therefore the impact of global warming might be more pronounced in boreal regions. The flow regime of a river is also affected by the changing climatic and environmental factors. The amount and unpredictability of rainfall have been predicted to increase in northern regions. The amount, timing, and variability of flow are among the fundamental environmental drivers structuring stream communities. Considering that freshwater ecosystems are already among the environments most heavily affected by anthropogenic activities, climate change clearly represents an additional and severe threat to freshwater ecosystems.

The main objective of this research project is to combine knowledge from ecology and hydrology to assess how climate change associated changes in stream hydrology will influence stream biodiversity (taxonomic and functional composition and richness). This project will constitute of three different subprojects. First, we will combine hydrological and biological models to predict the reference condition (i.e. present-day distributions) of stream assemblages. Second, we will model how ecologically important aspects of the flow regime will change in response to climatic change and how these changes will affect the diversity of stream assemblages at regional and local scales. Third, we will experimentally assess the responses of stream communities to multiple stressors emerging from climate change, such as changing discharge and amount of sediments. In addition, we will assess how climate change might affect the Finnish national assessment system for rivers and streams and how assemblages in streams already stressed by anthropogenic disturbances are likely to respond to climate change.

The interdisciplinary approach of this project will allow examination of stream assemblages and their relationships to changing environment in a great level of realism. Results from this project will provide urgently needed information about how rivers and their assemblages are likely to respond to climate change and where the effects of climate change are likely to be most pronounced. This information will allow guidance of regional managers for the protection of natural rivers as well as restoration of rivers already degraded by anthropogenic activities.

Automatization of groundwater level measurements in Finland and the flow of information to end users

Risto Mäkinen, Hannu Sirviö and Harri Laitinen

Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland, e-mail: risto.p.makinen@ymparisto.fi, hannu.sirvio@ymparisto.fi, harri.laitinen@ymparisto.fi

A nation–wide monitoring programme for evaluation of the changes in groundwater level and quality has been carried out in Finland since 1975. The data is based on network of 60 groundwater observation stations in different climatological conditions and soil types located in areas where, from the beginning, the human impact for groundwater quantity and quality has been subtle. The stations are located in hydrogeologically unified groundwater basins or districts, that is, defined areas within larger basins. The size of the area investigated varies between 0.2 km^2 and 3.0 km^2. The groundwater of these monitoring stations is in most cases 'shallow groundwater' and its potential use for domestic water applies mostly to sparsely populated areas. Groundwater levels are measured twice a month and groundwater samples are taken two-four times each year from springs, wells or sampling tubes.

The groundwater levels are monitored by measuring the water stages in approximately 10 observation tubes at every station. The observations are converted into elevations above sea level according to the N60 -altitude system, which gives a comparable value. An average groundwater level for every station is calculated with these values. The observations are stored into the national groundwater data system (POVET), which is maintained by the Finnish Environment Institute and the regional centres for economic development, transport and the environment.

Continuous water level sensing equipment is becoming increasingly important for the groundwater monitoring. Five groundwater stations have been automated by this using 4-8 data loggers each. Loggers are situated in an equipment cabinet located next to the tube. They are self-contained units equipped with data-logger, pressure sensor, GSM-modem, battery and solar panel. Measurements are taken at intervals of fifteen minutes, and hourly average values stored in the logger's memory. Transmission will take place once a day by data collection engine that is located in SYKE, Helsinki. GSM-data is used in the data transfer.

Each automatic ground water tube has its own data logger. Measured values are collected from data loggers by a control program software that writes the measured values to a text file. The groundwater level and temperature values are then transferred to a database called "Hydrotempo". Collection is made once a day. Raw values are indicated by either the height of the water level above the measurement sensor or mA reading , which are converted to the water level using a linear transformation. A tube-specific correction is then added to the water level, This correction converts the values as if they were measured from the upper end of the tube downwards. The calculated instantaneous values are then saved in a database table. Daily averages are then computed from the measured values using arithmetic average. Daily averages transferred from Hydro-tempo groundwater table to POVET groundwater height table.

The effect of water table rising on DOC, N, P, and Fe release from restored peatland forests

Mika Nieminen[1], Annu Kaila[1], Sakari Sarkkola[1], Zaki Asam[2], Liwen Xiao[2], Ari Laurén[3] and Hannu Hökkä[4]

[1]Finnish Forest Research Institute, Southern Regional Unit, P.O. Box 18, FIN-01301 Vantaa, Finland, e-mails: mika.nieminen@metla.fi, annu.kaila@metla.fi, sakari.sarkkola@metla.fi
[2]Civil Engineering, National University of Ireland, University Road, Galway, Republic of Ireland, e-mails: z.asam1@nuigalway.ie, liwen.xiao@nuigalway.ie
[3]Finnish Forest Research Institute, Eastern Regional Unit, P.O. Box 68, FIN-80101 Joensuu, Finland, e-mail: ari.lauren@metla.fi
[4]Finnish Forest Research Institute, Northern Regional Unit, P.O. Box 16, FIN-96391 Rovaniemi, Finland, e-mail: hannu.hokka@metla.fi

Peat accumulating wetlands, i.e. peatlands are a characteristic part of the landscape and an integral part of the hydrological cycle in the boreal zone. Natural peatlands provide ecosystem services such as climate buffering as storage of carbon. Peatlands also have a role in flood regulation and they can be seen as filters for outflow waters from upland forests. With the beginning of large-scale drainage in the 1950´s, however, over 50% of the original peatland area in Finland has been ditched in the interest of forestry, equalling to one-third of all forestry-drained peatlands in the world. Later the attitudes towards peatlands started to change as their ecological functions were understood better and major restoration work is now carried out to restore the ecosystem services provided by natural peatlands.

However, the results so far indicate that some of the effects of restoration may be negative from the environmental protection viewpoint. It has been shown that active restoration work by filling-in the ditches and cutting the tree stand formed after drainage may initially lead to highly increased P, N, and DOC exports to recipient water bodies. However, the results are contradictory; some studies show highly enhanced P and DOC transport, while some sites indicate that the effects of restoration are negligible. These contrasting findings are hypothesized to be because the rising of water level following restoration leads to different release behavior between the sites with differing peat chemical and physical properties.

To clarify the effect of water table rising on nutrient and DOC release, we carried out a laboratory experiment, where peat from 7 sites (5 from Finland, 2 from Ireland) were incubated in water-tight PVC pipes at 18 ^{o}C for about 7 months. Four columns per site were incubated under anaerobic waterlogged conditions and four under field soil moisture content with low water table. Soil water samples were taken fortnightly or once a month from a depth of 10-20cm using suction samplers with a polymeric tip of 9 cm in length and 4.5 mm in diameter, attached to a removable syringe generating a suction of 100 kPa.

The results indicated significant differences in P, N, Fe, and DOC release from water-logged (high water table) columns, ranging from almost no increase to over hundred-fold increase compared with the columns at field moisture content (low water table). In Finnish sites, P release was significantly higher from the rewetted ombrotrophic than the nutrient-rich, minerotrophic peats. Fe, DOC, and $NH4^{+}$-N were released from the most nutrient rich peat. In Irish sites, release of nutrients and DOC was significantly higher from highly decomposed blanked bog peat than from less humified blanket peat. The results supported our hypothesis that the rate of DOC and nutrient release from peat following rewetting is different for sites with differing soil characteristics. Future studies will focus on clarifying the factors and processes behind the between-site differences in DOC and nutrient release.

The use of stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) in discriminating different forms of peatland use and estimating ecological impacts in stream communities

Mika L. Nieminen[1,2], Emmanuela Daza Secco[2] and Kristian Meissner[1]

[1]Finnish Environment Institute, Survontie 9, FI-40500 Jyväskylä, Finland,
e-mail: mika.nieminen@ymparisto.fi
[2]University of Jyväskylä, Department of Biological and Environmental Science, P.O. Box 35, FI-40014 Jyväskylän yliopisto, Finland

Different sources of carbon and nitrogen in aquatic food webs can have distinct stable isotope compositions, denoted with $\delta^{13}C$ and $\delta^{15}N$ values respectively. Stable isotope analysis can be an effective tool in carbon flow studies, as well as in estimating the trophic positions of consumers in food webs. Stable isotopes also provide opportunities for partitioning energy flow in aquatic ecosystems. In this study, we try to define the significance of the sources of organic matter (OM) in our study sites.

We aimed to discriminate the effects of different land use patterns in peatlands affecting the sources of OM within three watersheds. Within each watershed, one stream drains a subcatchment affected only by peat mining, whereas the other stream flows through a subcatchment affected by forestry. These two subcatchment streams then merge to form a single stream flowing into a lake. Studied watersheds were subject to no other forms of land use. In addition to the impacted sites, we used two pristine natural mire and two natural forest catchments as controls.

We analysed the stable isotopes of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) from benthic macroinvertebrates, stream bank soil, stream sediment, and dissolved organic carbon (DOC) in stream water. Samples were collected separately at impacted stream sites and 50 m downstream of their confluence as well as at the control sites. Samples for stable isotope analyses were collected in the summer of 2011 and samples for benthic macroinvertebrate community analyses in the autumn of 2011. Upon sampling we measured physical parameters, such as stream width, depth, flow velocity, and discharge at each sampling site.

Our initial results on the stable isotope analyses of benthic macroinvertebrates suggest some degree of discrimination between different sources of OM. We will explore this result further by examining not only taxonomical structure, but also the role functional feeding groups have on results. Our results will be used in estimating the significance of different sources of OM in the diets of benthic macroinvertebrates. Initial results on community structure in response to land use indicate the importance of site location over land use effects. We suggest that stable isotopes should be interpreted together with benthic macroinvertebrate community analyses to be able to assess ecological impacts of different peatland uses with respect to changed food quality. In future studies, we will address the need to look at the quality and quantity of OM in more detailed level, to provide more insight into the effects of different forms of peatland use on aquatic ecosystems.

Isotopic tracers and microbial life at an artificial recharge plant in Southern Finland

Paula Niinikoski[1], Johanna Ojala[2], Nina Kortelainen[3] and Juha Karhu[1]

[1]Department of Geosciences and Geography, University of Helsinki, P.O. Box 64, FIN-00014 Helsingin yliopisto, Finland, e-mail: paula.niinikoski@helsinki.fi
[2]Tampere University of Technology, Tampere, Finland, e-mail: Johanna.ojala@tut.fi
[3]Geological Survey of Finland, Espoo, Finland, e-mail: nina.kortelainen@gtk.fi

The objective of this study was to examine the decomposition of dissolved organic carbon (DOC) in an artificial groundwater plant at Tuusula, Southern Finland, by using the isotopic composition of carbon in dissolved inorganic carbon (DIC) and to combine this information with knowledge from microbial communities. Artificial recharge of surface water is used to reduce the content of dissolved organic carbon (DOC) to the drinking water level (Kortelainen and Karhu, 2006). Samples from groundwater observation wells, infiltration water and local natural groundwater were collected between November 2008 and May 2009 after Lake Päijänne water was reintroduced to the system following the temporary infiltration of chemically processed, drinking quality water from River Vantaa. $\delta^{18}O$, $\delta^{13}C_{DIC}$ and the contents of DOC in water were analyzed. The contents of DIC were calculated with a geochemical modelling program PhreeqC from measured alkalinity and pH values. The composition of bacterial communities in the groundwater system was investigated using the semi-quantitative method of length heterogeneity PCR.

The low DOC concentration of River Vantaa water remained approximately constant along the flow path. There were changes in the calculated concentration of DIC, however, no notable changes in its isotopic composition, which would have been apparent had there been oxidative decomposition of DOC. The microbial community in River Vantaa water differed from that of Lake Päijänne water and the mixing of the waters was evident from the bacterial community profiles. Microbial cell counts remained similar during the water change.

According to the $\delta^{18}O$ signal in the system, the water from Lake Päijänne travelled 450 metres in less than two months. As it was reintroduced to the system, the $\delta^{13}C_{DIC}$ values of infiltrated water increased, and a steep drop in the $\delta^{13}C_{DIC}$ values occurred in the immediate vicinity of the infiltration pond. After this, the decrease was more restrained. The content of DOC decreased and the content of DIC increased correspondingly. This indicates that microbial decomposition of DOC was operating in the system.

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Balancing water for humans and nature through 3 weirs in Geum river, South Korea

Jaekyoung Noh[1], Jaenam Lee[2], and Young Dae Cho[3]

[1]Department of Agricultural and Rural Engineering, Chungnam National University, P.O. Box 305-764, 99 Daehangro Yuseong-gu Daejeon, South Korea, e-mail: jknoh@cnu.ac.kr
[2]Department of Agricultural and Rural Engineering, Chungnam National University, P.O. Box 305-764, 99 Daehangro Yuseong-gu Daejeon, South Korea, e-mail: jnlee@cnu.ac.kr
[3]Technology Consulting Center, 4 Rivers Project Headquater, K-Water, P.O. Box 306-711, 560 Sintanjinro Daedeok-gu Daejeon, South Korea, e-mail: choyd@kwater.or.kr

The 3 weirs were constructed in Geum river, South Korea in 2011. The Geum river has the basin area of 9,810 km^2, the length of 397.2 km, of which the Baekje weir is locate in site of 270.5 km away from headwaters and has the watershed area of 7,924 km^2, the Gonju weir in 245.7 km and 7,352 km^2, and the Sejong weir in 227.7 km and 6,887 km^2. The management water levels and water storages are EL.4.2 m and 24.87 Mm^3, EL.8.75 m and 15.27 Mm^3, EL.11.8 m and 5.44 Mm^3, respectively. The multipurpose dams called Daecheong and Yongdam, are located in 193 km, 57 km away from headwaters, respectively, of which watershed areas and capacities are 4,134 km^2 and 1,490 Mm^3, 930 km^2 and 815 Mm^3, respectively. From the Yongdam dam, domestic and industrial water of 492.8 Mm^3 are planned to supply to the Geum river basin outside, and irrigation water of 492.7 Mm^3 and instream flow of 157.7 Mm^3 are supplied to downstream on annual, respectively. From the Daecheong dam, domestic and industrial water of 1,300 Mm^3 are planned to supply on annual, and irrigation water of 349 Mm^3 is also supplied.

Land uses of the Baekje weir sub watershed of 572.6 km^2 are upland of 41.36 km^2 (7.2%), paddy field of 90.0 km^2 (15.7 %), forest of 395.22 km^2 (69.0%), village of 10.76 km^2 (1.9 %). The Gongju weir of 465.4 km^2 is consisted of upland of 34.16 km^2 (7.3%), paddy field of 67.14 km^2 (14.4 %), forest of 318.9 km^2 (68.5%), village of 15.84 km^2 (3.4 %). The Sejong weir of 2,753.4 km^2 which Daecheong watershed is excluded, are upland of 331.32 km^2 (12.0%), paddy field of 699.17 km^2 (25.4 %), forest of 1,366.43 km^2 (49.6%), village of 191.26 km^2 (6.9 %). The Daecheong dam of 4,134 km^2 is consisted of upland of 284.79 km^2 (6.8%), paddy field of 549.99 km^2 (13.1 %), forest of 3,129.29 km^2 (74.7%), village of 90.23 km^2 (2.2 %).

The paddy field areas of Baekje, Gongju, Sejong weir are 878 ha, 497 ha, and 489 ha, respectively, to which waters are supplied from pumping stations along river. Here this irrigation water was defined to water for humans, and the downstream outflow to water for nature. The available waters and storages from 3 weirs were simulated on a daily basis with 90% reliability, with 3 weirs taken to reservoir. Paddy water requirements, reservoir inflows and water storages were simulated to each reservoir cascaded on a daily basis, respectively.

The Sejong weir was analyzed to be able to supply irrigation water of 29.18 Mm^3, instream flow water of 411.86 Mm^3, and overflow water of 4,673.50 Mm^3, the Gongju weir to 38.48 Mm^3, 474.11 Mm^3, 5,117.58 Mm^3, and the Baekje weir to 61.56 Mm^3, 551.03 Mm^3, 5,158.21 Mm^3 on an annual average from 1966 to 2010, respectively. The annual averaged inflows to 3 weirs were analyzed to 5,117.58 Mm^3, 5,401.21 Mm^3, 5,777.29 Mm^3, respectively. Waters for humans were 0.6%, 0.7%, 1.1%, and waters for nature were 99.4%, 99.3%, 98.9%, respectively, with weirs' water storages maintained to reliability of 90%. Waters for humans need to be increased, but this was shown to be limited from low water storages of 3 weirs. To increase the ratio of water for humans, the operation schedules of weirs should be analyzed carefully.

Balancing water for humans and nature through irrigation reservoirs in South Korea

Jaekyoung Noh

Department of Agricultural and Rural Engineering, Chungnam National University, P.O. Box 305-764, 99 Daehangro Yuseong-gu Daejeon, South Korea, e-mail: jknoh@cnu.ac.kr

South Korea has land area of 99,898 km^2 of which paddy field is 10,460 km^2 (10.5%), upland is 7,128 km^2 (7.1%), and forest is 64,598 km^2 (64.7%). Irrigated paddy area is a total of 831,553 ha which is consisted of 467,185 ha (56.2%) from reservoirs, 169,745 ha (20.4%) from pumping stations, 86,222 ha (10.4%) from weirs. Number of irrigation reservoirs is 17,611 as of 2008 of which only 475 is for total storage above 1 Mm^3. Project of heightening 96 irrigation reservoirs is now going on in Korea to secure water storages of 242 Mm^3 from which 340 Mm^3 is for instreamflow downstream and 350 Mm^3 for flood control.

Most of irrigation reservoir has been used for supplying only irrigation water to paddy fields in Korea. Little water has flowed into downstream of reservoir in no irrigation period up to now. But more water will flow into downstream in no irrigation period by heightening irrigation reservoir. Allocation will commence to balance water between humans and nature. Bakgog irrigation reservoir was selected to evaluate water allocation between irrigation volume for humans and instream volume downstream for nature as a case study. Flood control volume below full water level was considered to regulate flood and operation rule curve was drawn to supply waters.

Bakgog reservoir with watershed area of 84.79 km^2 and irrigated paddy field area of 2,975 ha is located in Jincheon county, Chungbuk province, of which full water level will be heightened from EL. 100.1 m to EL. 102.1 m, and total storage from 21.75 Mm^3 to 26.67 Mm^3. Flood inflow with 200 year frequency was estimated to 997 m^3/s in peak flow and 2,254 Mm^3 in total volume. Reservoir flood routing was conducted to determine flood limited water levels, which was determined to have scenarios such as EL 97-98-99 m in periods of 6.21.-7.20., 7.21.-8.20., and 8.21.-9.20., that is rainy season in summer, respectively, EL 97-97-97 m, EL 98-98-98 m in present reservoir, and EL 99-100-101 m, EL 99-99-99 m, and EL 100-100-100 m in heightened reservoir.

Reservoir inflow was simulated by DAWAST model. Annual paddy irrigation requirement was estimated to 33.19 Mm^3 to 2,975 ha. Environmental flow was allocated to 0.14 mm/d from October to April that is not irrigation period. Operation rule curve was drawn using inflow, irrigation and environmental flow requirements data. In case of withdrawal limit reservoir operation using operation rule curve, annual irrigation supply before and after flood control by reservoir was 31.51 Mm^3, 30.14~30.87 Mm^3 in present size, and 32.93 Mm^3, 31.75~32.45 Mm^3 in heightened size, respectively, reduction rate was 2.0~4.3 %, and 1.5~3.6 %. Reliability on water supply was decreased from 77.3 % to 63.6~68.2 %, from 81.6 % to 72.7~79.5 %, respectively. And water storage at the end of year before and after flood control by reservoir was 17.80 Mm^3, 14.87~16.49 Mm^3, and 21.85 Mm^3, 18.16~20.17 Mm^3, respectively, reduction rate was 7.3~16.5 %, and 7.7~16.9 %, respectively.

But water supplies were done without any water deficiency through withdrawal limit reservoir operation in spite of low flood regulating water level. The present instream water supply capacity was 33,000 m^3/d (6.33 Mm^3/y) while 38,000 m^3/d (7.45 Mm^3/y) in 2 m heightened condition in case of withdrawal limit operation with flood control volume. The present irrigation water supply capacity was 29.00 Mm^3/y while 30.70 Mm^3/y in 2 m heightened condition in the same condition above. Water balance between humans and nature is 29.00~30.70 to 6.33~7.45, that is 4.12~4.58 to 1.0. Water allocation through irrigation reservoir was 81 % for humans and 19 % for nature in this case.

Geomorphological-ANN Based Modeling for Estimation of Suspended Sediment Load

Vahid Nourani[1], Aida Hosseini Baghanam[2] and Elnaz Sharghi[3]

[1]Associate Prof., Dept. of Water Engineering, Faculty of Civil Eng., Univ. of Tabriz, Iran,
e-mail: nourani@tabrizu.ac.ir , vnourani@umn.edu
[2]M.Sc. Student, Dept. of Water Engineering, Faculty of Civil Eng., Univ. of Tabriz, Iran
e-mail: hosseinibaghanam@gmail.com
[3]PH.D. Candidate, Dept. of Water Engineering, Faculty of Civil Eng., Univ. of Tabriz, Iran
e-mail: elnaz_sharghi@yahoo.com

Estimation of suspended sediment load is required in a wide range of water resources engineering problems. The suspended sediment load in a watershed is highly variable in space and time. Generally it is related to the discharge but a couple of space depended geomorphologic parameters can interfere in estimations as well.

The nonlinear nature of suspended sediment load series necessitates the utilization of nonlinear methods for simulating the process. In this study an ANN model was developed for semi-distributed modeling of suspended sediment load process of the Eel River watershed located in California, USA. The neural networks are trained using both time depended meteorological data and space depended geomorphologic parameters of the sub-basins, extracted by GIS (Geographic Information System) tool. A three-layer feed-forward ANN structure was constructed and a back-propagation algorithm was used for the training of various combinations of inputs. Furthermore, the efficiency of the model for spatiotemporal modeling of the process was verified by cross validation technique for a station.

The results revealed adequate coincidence in observed and predicted suspended sediment load data. The simultaneous imposition of temporal and special data to the geomorphological ANN model led to a non-linear time-space regression model rather than a fully lumped model.

Keywords: Semi-distributed model; Suspended sediment prediction; Artificial neural networks; Geomorphology; GIS; Eel River

River water quality in Kittilä, Finnish Lapland

Paavo Närhi[1], Pekka Hänninen[2], Maarit Middleton[1] and Raimo Sutinen[1]

[1]Geological Survey of Finland, P.O. Box 77, 96101 Rovaniemi, Finland, e-mail: paavo.narhi@gtk.fi, maarit.middleton@gtk.fi, raimo.sutinen@gtk.fi
[2]Geological Survey of Finland, P.O. Box 96, 02151 Espoo, Finland, e-mail: pekka.hanninen@gtk.fi

Surface water quality is a matter of great concern today. Nutrients and other chemicals can cause eutrophication and toxic contaminations of watersheds, hence leading to depletion of dissolved oxygen, increase in phytoplankton, and to changes in species compositions. Especially metals constitute a threat to ecosystems because they can be toxic even at low concentrations and can bioaccumulate. Potential anthropogenic and natural water contamination sources were studied in Kittilä municipality (8000 km^2, population 6000), the area known of currently active gold exploration in Finnish Lapland. The active Suurikuusikko gold mine, the largest in Europe, is composed of arsenopyrite-gold deposits. Also tailings of former Saattopora gold mine (1988-1995) are a potential source of water contamination. The infrastructure, including Levi ski resort, Kittilä airport, Kittilä town, as well as forestry (mechanical site preparation and drainage) may have impact on water quality, whereas the role of agriculture is minor. We analyzed concentrations of river water As, Ca, S, and SO_4 (sulfate) at 45 sites using ICP-AES, ICP-MS, and ion chromatography. In addition, electrical conductivity (EC) was point-wise measured at 54 sites and with continuous logging along Ounasjoki river (30 km distance with 3500 measurements) using CS547 conductivity probe with Cambell logger.

Tailings of the former Saattopora mine were the source of S (up to 4.6 mg l^{-1}) and SO_4 (13.8 mg l^{-1}), whereas in other areas the concentrations were 0.75-2.5 mg l^{-1} and 2.2-7.3 mg l^{-1}, respectively. The Iso-Kuotko arsenopyrite-gold deposit produced natural downstream As concentration of 18.7 µg l^{-1}. Other gold deposits/mines formed As up to 4.8 µg l^{-1}, whereas in uncontaminated areas As concentrations varied from 0.06 to 2 µg l^{-1}. The EC and Ca downstream from the gold deposits/mines were up to 12.4 mS m^{-1} and 19.7 mg l^{-1}, whereas rest of the measured values were 3.2-10.4 mS m^{-1} and 4.1-15 mg l^{-1}, respectively. Continuous EC measurements in Ounasjoki river showed values up to 7.5 mS m^{-1} in Kittilä town and associated with major forest drainage areas, whereas upstream values varied between 4.9 and 5.3 mS m^{-1}. In conclusion, gold deposits and especially the tailings of the former Saattopora mine substantially increased watershed S, SO_4, As, Ca, and EC, whereas forestry resulted in smaller increase in the stream water EC. Tailings can release substantial amounts of metals and nutrients for a long period of time, and the present results emphasize the importance of efficient stabilization of tailings to protect aquatic ecosystems.

Environmental flow - concept; how to understand and apply in regulated rivers

Sini Olin[1], Antton Keto[2], Seppo Hellsten[3]

[1, 2, 3]Finnish Environment Institute, PL 140, FIN-00251 Helsinki, Finland,
e-mail: sini.olin@ymparisto.fi, antton.keto@ymparisto.fi, seppo.hellsten@ymparisto.fi

The river flow can be altered by using dams and weirs to regulate natural rhythm of flow or more commonly by building reservoirs to change permanently quantity of water flow. The organisms living in rivers and riparian areas have adapted to a natural dynamics of river. Even small changes in natural flow can significantly undermine the river ecosystem, due to sensitive balance between biota and environmental conditions in the river.

The basic idea of the environmental flow is to maintain the quantity, quality and duration of the flow sufficient to maintain the river and riparian ecosystem in a good state. Environmental flow methods are used for example to protect vulnerable fish species, riparian vegetation, water quality and groundwater. In general environmental flow methods are classified by the hydrological, hydraulic, habitat simulation and holistic methods. Holistic methods are the most advanced as they take into account many important elements in river and riparian area instead of other methods focusing mainly on one species.

Environmental flow concept was originally developed in the United States in late 1940s for the protection of important fish species, but the active use of environmental flow methods began in the 1970's. Outside the United States, for example in Australia, South Africa, UK and New Zealand, the use of environmental flow methods increased in the 1980s. Shortly after this, the method became widely used for example in Brazil, Japan and Portugal. Surprisingly methodology is very rarely used and literature is difficult to find in the other part of the world.

Although the concept of environmental flow is relatively young, it has been used to describe more than 100 different approaches. In addition, environmental flow methods are routinely used for water resources management at least in 30 countries and the number is increasing every year especially in arid zone.

Environmental flow is a relatively new concept in Finland. Principles behind the concept have been applied on case by case basis, but there are no common principles of environmental flow assessment. In current approach environmental flow principles were applied in fully developed lower part of the River Iijoki, northern Finland. Our approach included a model taking in to account both water level and flow changes in river stretch with evaluation of the effects on selected species (salmon and trout) and habitats (flood forest).

Evaluation of short-term precipitation in high-resolution RCM simulations over Sweden

Jonas Olsson[1], Anna-Maria Gustafsson[2] and Magnus Persson[3]

[1]Research & Development (hydrology), Swedish Meteorological and Hydrological Institute, S-60176 Norrköping, Sweden, e-mail: jonas.olsson@smhi.se
[2]Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology, S-97187 Luleå, Sweden, e-mail: anna-maria.gustafsson@ltu.se
[3]Department of Water Resources Engineering, Lund University, S-22100 Lund, Sweden, e-mail: magnus.persson@lth.tvrl.se

Detailed information about the precipitation distribution in time and space is required for simulation of some key small-scale hydrological processes such as urban storm drainage and local water quality or solute transport. In terms of observations, this requires devices with a high resolution in preferably both time and space. Precipitation gauges may give a very high time resolution, down to seconds (tipping-bucket gauges or advanced sensors), but dense networks with short-term gauges are very unusual. In Sweden, a national network of some 120 short-term (15-min) gauges are in operation since the mid-1990s, with a mean distance between the gauges of about 60 km. Weather radar may provide precipitation observations with an excellent resolution in both time (5-10 min) and space (2-4 km), but (1) the precipitation intensity is uncertain as it is only indirectly estimated and (2) long and consistent time series are seldom available. Thus, short-term gauges are currently the best source of information.

Climate change is expected to affect precipitation towards more intense events. As the most intense events are generally of a local nature, e.g. related to generation of convective cells, the climate change impact on precipitation would therefore be most pronounced on the local scale. The spatial resolution of the current Regional Climate Models (RCMs) used to generate future projections of regional climate has been too coarse to properly describe small-scale precipitation processes, e.g. convection. The resolution is however gradually increasing, from the original 50×50 km to 25×25 km, which may be regarded as standard today, and even further down to resolutions below 10×10 km. In light of the extreme space-time variability of precipitation, spatial averages over areas $\leq$100 km² are conceivably much more similar to local (i.e. point) precipitation than spatial averages over areas of 1000-2000 km². Consequently, these high-resolution projections would potentially be significantly better suited for small-scale hydrological climate change impact assessment.

Analyses of precipitation data from high-resolution RCM simulations over Sweden, by the RCA3 model have been performed. The main focus is on the 12.5×12.5 km resolution. In 10 locations distributed over Sweden, statistical properties of 30-min time series are compared with observations from the national network in a 15-year period (1995-2010). The statistical properties considered include total amounts, maximum intensity and precipitation frequency. The results are mixed, some aspects of short-term local precipitation are reasonably well reproduced by the 12.5×12.5 km RCM whereas other aspects are not. In general the RCM gave higher total volumes and lower maximum intensities compared to measured data. The lower maximum intensities are expected since point measurements are compared to simulated areal precipitation. Also the expected changes of the short-term precipitation in a future 12.5×12.5 km projection are characterised. For some locations, an extended evaluation of the impact of RCM resolution (from 50×50 km to 6.25×6.25 km) on the accuracy of simulated precipitation is performed. This analysis indicates that the reproduction of especially short-term local extremes is substantially improved with an increased RCM resolution.

Atlantic salmon passage in the regulated River Oulujoki, northern Baltic Sea

Panu Orell, Aki Mäki-Petäys, Jaakko Erkinaro and Petri Karppinen

Finnish Game and Fisheries Research Institute, P.O. Box 413, FI-90014 Oulu, Finland,
e-mail: panu.orell@rktl.fi

The first fish pass in the former salmon river, the River Oulujoki in northern Finland, was constructed in 2003 on the lowermost hydropower dam at the river mouth. Atlantic salmon passage through the new fish pass and their behavior in the lowermost part of the regulated river below the second dam were studied in 2005-2011 using radio- and PIT-telemetry techniques in addition to video surveillance.

The PIT-tagging experiment revealed a lag of several weeks between the arrival to the tailrace area and the fish pass entrance. In general, salmon entry to the River Oulujoki is very late compared to other salmon rivers in the area. The salmon used a mean of 2-3 days for the c. 1000m fishway passage, but this lag varied a lot between individuals. Radio-tagged salmon used only 1-2 days to migrate through the 40km river stretch (impoundment) until the second dam.

Both tagging experiments and the video surveillance indicated that the ascending salmon population consists mostly on small (one-sea-winter) male salmon, and the proportion of large females is very small. As activities for the rebuilding of the Oulujoki salmon stock are underway, this bias should be seriously addressed, and more egg-producing large females are needed for the returning population. Possible solutions include tuning the hydrology at the fish pass entrance by increasing the attraction flow and changing the operation of the power plant, and also changes in stocking practices and fishery management at the river mouth.

Ground frost variation in Finland

Mirjam Orvomaa and Risto Mäkinen

Finnish Environment Institute, P.O. Box 140, FI-00251 Helsinki, Finland, e-mail: mirjam.orvomaa@ymparisto.fi , risto.p.makinen@ymparisto.fi

Ground frost has been measured by the Finnish Environment Institute and its prior organizations at some locations since the 1920's, and a more extensive network has been monitored since the 1950's. The present network consists of circa 40 ground frost stations that are situated across the country, and represent a variety of climatic conditions in different soil, forest and mire terrains. These stations, together with the ground frost observations made at the groundwater monitoring sites, and the small catchments areas monitoring sites form a combined ground frost monitoring network that consists of circa 700 measuring sites.

Ground frost has been measured by different methods throughout the 20th century. Methylene blue tubes replaced other methods in the 1970's and have been used exclusively since then because the results it produces are more comparable than those obtained with previous methods. Observations are made during the winter time every 6th, 16th an 26th day of the month. Moreover this, the observations are denser when ground frost is thawing. The ground frost stations measurements represent results from naturally occurring ground frost and snow cover.

Snow depth and the frost sum are the major factors effecting frost depth. The freezing and thawing is affected by the soil type, soil moisture, groundwater levels, and the terrain in general. The regional variations of snow depth can differ tremendously, which is explained by the above listed factors and by the timing of snowfall versus the starting period of frost weather. This study presents the regional variations of ground frost at six regionally representative monitoring sites during the past thirty to sixty years. In short, the southwestern and coastal regions of Finland often have more ground frost than the eastern and northern regions due to differences in snowfall periods. Ground frost penetrates deeper without an isolating snow cover.

Depending on the geographical location, the period of ground frost occurrence varies between four to eight months, which is relatively long in European perspective. The maximum ground frost depths are generally registered in the southern and central parts of the country in February- March and in the northern parts in late March. The thickness of ground frost can vary between 0- 200cm. The thawing rate is dependant on how spring proceeds yearly.

The winters in Finland are anticipated to become substantially milder during this century and thus snow cover will become thinner especially in the southern and central parts of the country (Veijalainen et al., 2012). These factors amongst others will affect ground frost thickness and occurrence in the future. The changes in the depth and occurrence periods of ground frost during the past fifty years help predict the effects of climate change in the future. The assets and constraints of the decrease or disappearance of ground frost is also discussed in this study.

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Modeling water system in Soub Basin Deçan

Lavdim Osmanaj[1] and Alfred Lako[2]

[1]N.N.SH. " VIZION PROJECT ", Rr. Major Mehmet Bushi. Ll 19. Nr 14, Quartier " Bregu i Diellit ", Prishtina, Repulic of Kosovo, e-mail: olavdim@yahoo.com
[2] N.N.SH. " VIZION PROJECT ", Tirane, Republic of Albania, e-mail: alfredlako@yahoo.com

The territory of the Republic of Kosovo has four river basins: the White Drin Basin, the Iber Basin, the Binca of Morava Basin and Lepenci Basin.

Deçani Underbasin is part of the White Drin River Basin and is the most important underbasin of this basin, as it supplies water to approximately 30,000 inhabitants, irrigation for a large quantity of land, and to the main accumulation of Dukagjin.

In this paper, we make modeling to the Deçan Underbasin with WEAP program, where we have evaluated resources and needs, and based on this modeling, we have derived the results for each user. Also, we have determined the time periods when irrigation is not possible, when water supply priority for 30,000 residents is presented.

Results of this study have a positive impact on the optimization of water permits issuing.

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Nutrient transport from agricultural fields to river water: On-farm monitoring study in Southern Finland

Maija Paasonen-Kivekäs[1], Jyrki Nurminen[2], Helena Äijö[2], Laura Alakukku[3], Harri Koivusalo[4], Merja Myllys[5], Markku Puustinen[6], Mika Turunen[4] and Lassi Warsta[4]

[1]Sven Hallin Research Foundation, Simonkatu 12 A 11, FI-00100 Helsinki, Finland, e-mail: maija.paasonen@hallin.fi
[2]Finnish Field Drainage Association, email: jyrki.nurminen@aalto.fi, helena.aijo@salaojayhdistys.fi
[3]University of Helsinki, Department of Agrotechnology, email: laura.alakukku@helsinki.fi
[4]Aalto University, School of Engineering, e-mail: harri.koivusalo@aalto.fi, mika.turunen@aalto.fi, lassi.warsta@aalto.fi
[5]MTT Agrifood Research Finland, e-mail: merja.myllys@mtt.fi
[6]Finnish Environment Institute, e-mail: markku.puustinen@ymparisto.fi

Agricultural production has been estimated to account for about 68% of the total human induced P load and 57% of the respective N load entering watercourses in Finland. Major part of these losses comes with runoff waters from arable land. The aim of this study is to quantify nutrient losses on field scale and to improve understanding of how phosphorus, nitrogen and eroded soil are transported via subsurface drainage flow and surface runoff into a body of surface water. The results will be used for planning of water pollution control measures in subsurface drained field areas.

The on-farm monitoring study is carried out in two field sections bordering the River Kirkkojoki, in Siuntio in southern Finland. The experimental field 1 one has an area of 5.7 ha and an average slope of 1%. The surface area of the field 2 is 4.7 ha and the average slope 5%. Clay fraction (particle diameter < 0.002 mm) form major part of the top and bottom soil in the both of the fields. The subsurface drainage system was installed in the 1940's. The fields are under conventional crop cultivation or pasture during the study period. Subsurface drainage flow and surface runoff from each field section are measured every 15 minute. On the water samples, concentrations of total nitrogen (total N), sum of nitrite and nitrate nitrogen (NO_2-N+NO_3-N), total phosphorus (total P) and soluble phosphate phosphorus (PO_4-P) and total suspended solids (TSS) are analysed in the laboratory. The measurements started in autumn 2007 and will continue to the end of 2013. Nutrient concentrations of the River Kirkkojoki water were determined in 2008-2009.

Subsurface drainage flow accounted for remarkable part of the annual total runoff (drain flow + surface runoff) also in the steeper field 2 in the years 2008-2011. Annual total P load via subsurface drains varied greatly, from 0.1 to 3.9 kg ha^{-1}, between the fields and years. The highest loss came from the field 2 (autumn wheat) in 2008 with high precipitation (838 mm) and exceptionally mild winter. Major part of the load was particle P. Both the total and soluble P concentrations were much higher in the field 2 than in the field 1 which was partly attributed to the difference in soil P status. The highest annual TSS load via tile drains, 2430 kg ha^{-1}, was also measured from the field 2 in 2008. In 2009-2011 the TSS load remained 270-919 kg ha^{-1} a^{-1}. Total N load via tile drains varied from 6.2 to 29.2 kg ha^{-1} a^{-1}. The highest losses were measured from the field 1 in 2008 and 2011 much due to the high subsurface drainage flow (509 and 413 mm, respectively). The role of surface runoff remained partly unclear due to measurement problems during the snow melt period in 2009-2011.

Besides the data analysis, mathematical models will be applied to the field sections to evaluate groundwater flow and other components of the water balance and factors affecting runoff generation, nutrient transport and erosion.

Water level fluctuations of a drinking water reservoir in variable water demand conditions

Tiia Pedusaar[1] and Liisi Labo[1]

[1]Estonian Meteorological and Hydrological Institute, Mustamäe tee 33, 10616 Tallinn, Estonia, e-mail:tiia.pedusaar@emhi.ee

The regulation of aquatic systems for anthropogenic purposes (e.g., drinking water supply, agriculture, shipping channels, and hydroelectric power) is becoming common place across the world (Bimentel et al., 2004).

Lake Ülemiste, the fourth largest lake in Estonia (9.75 km^2; mean depth 3.4 m; maximum depth 5.2 m; total volume at normal pool level 32 Mm^3) is, in origin, a natural lake. It had multiple uses in the past, but now it serves solely as a source of water supply to the city of Tallinn. Regulation of the water level started in 1924. The natural catchment area of Lake Ülemiste (79 km^2) was enlarged by a factor of c. 23 in the period 1924-1987 to meet steadily increasing water demands of the city of Tallinn. Since the beginning of the 1990s, the city´s water consumption started to decrease (Pedusaar et al., 2010).

Long-term data (1880-2011) on water level in the Lake Ülemiste were compiled to reveal patterns of water level fluctuations in changing water demand conditions. According to the intensity of water consumption of the city, water level fluctuations were divided into four different time period: 1880-1923 (very low demand for water); 1924-1959 (slightly growing water demand); 1960-1990 (very active explotation of the lake) and 1991-2011 (period with trastically decreasing water demand) .

The mean lake level was lowest (66 cm ±7) for pre-regulation period (1880-1923). Since start of regulation, the annual water level showed a clear upward trend in time ($R=0.7$, $p=0.00$). However, despite active strategy for lake level regulation, there was considerable fluctuation in water levels. Paired t-test showed that mean amplitudes of the three first period (92 cm ±8, 99 cm ±4 and 102 cm ±6, accordingly) did not differ significantly from each other. However, in the declining water demand conditions (1991-2011), the mean water level remain significantly higher (188 cm ±1.6) and amplitude significantly lower (48 cm ±2) compared to earlier periods.

Fluctuations of monthly water levels of Lake Ülemiste reflected changes in the annual hydrologic cycle for different periods. Based on monthly mean water levels, there was still a weak seasonal water level fluctuation in 1924-1959 and 1960-1990, averaging 51 cm and 60 cm, accordingly. In 1991-2011, the magnitude of seasonal fluctuations was nearly negligible, averaging only 17 cm.

Thus, currently Lake Ülemiste has a very small inter-annual and intra-annual lake level variation. Relationships between water level fluctuations and city´s water demand are discussed.

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Paleohydrologic bounds and extreme flood frequency analysis of the Danube River at Bratislava, Slovakia

Pavla Pekárová, Ivan Mészáros and Pavol Miklánek

Institute of Hydrology SAS, 831 02 Bratislava, Slovakia, e-mail: pekarova@uh.savba.sk

The Flood Directive 2007/60/EC of EU requires, that the individual EU Member States shall prepare flood hazard maps and flood risk maps of very low flood probability of occurrence (in Slovakia with return periods of *1000* years). The insertion of the historic floods into the maximum annual discharge series significantly improves the correct estimate of low probability floods (*500–1000*-year floods). Therefore it is very important to include as many as available historic archive data into the measured series. The aim of this paper is to analyze the occurrence of the historical floods in the Upper Danube River (at Bratislava station) based on historical archive information (period 1000–1875), and measured discharge series at Bratislava station (period 1876–2010).

In the first part of the paper we identify a historic time period and a historic discharge threshold such that the record is known to include all peaks that exceeded the threshold of 12000 m^3s^{-1} at Bratislava station during the historic period. There exist several historic floods marks since the flood in 1501 in several cities on the German and Austrian reach of the Danube River (e.g. at Passau, Linz, Mauthausen, Ybbs, Stein, Hainburg, Budapest) mentioned by Kresser (1957). The information on year 1516 flood mark is known in Bratislava. The Danube flood in 1787 at Bratislava is very good described (Pišút, 2011). In historical documents we identified 5 historical floods (from the years 1012, 1210, 1501, 1670, and 1787), when the Danube discharge during the flood exceeded 12000 m^3s^{-1}.

In the second part we tested alternate models to provide a good approximation to flood-flow data. Firstly, we choose the type of theoretical distribution curve. We recommend the use of the log Pearson type 3 (LP3) distribution in flood frequency investigations.

Finally we compared the *T*-year discharge design values computed with and without historical flood values. We used the series of the annual maximum discharges *Qmax* of the Danube for the period 1876–2010 and 5 historical floods (from the years 1012, 1210, 1501, 1670, and 1787).

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Urban stream water quality monitoring and restoration in Longinoja brook, Helsinki

Katja Pellikka

City of Helsinki, Environment Centre, P.O. Box 500, FIN-00099 CITY OF HELSINKI, Finland,
e-mail: katja.pellikka@hel.fi

Urban streams are a part of blue-green infrastructure. They are vital green corridors for plants and animals and important recreation areas for people.

Longinoja brook is one of the largest streams in the City of Helsinki with the catchment area of 12 km^2 and the length of 6 km. It runs into the River Vantaa which runs into the Baltic Sea. One third of the Longinoja brook catchment area is impervious. The brook suffers from erosion, turbid and nutrient-rich water, waste water spills and trash dumping.

There have been small restoration projects in Longinoja during the last decade. Effects of these restorations have been monitored with electrofishing and the results have been promising; thanks to restoration and fish stocking the endangered sea trout (*Salmo trutta*) reproduces in the brook.

In autumn 2011 authorities restored 800m with an excavator in upper reaches of Longinoja. The excavator made the channel meandering, inserted large stones to the channel to divert water flow to create self-meandering, created gravel and stone areas for trouts and flooding plateaus for water to flood in a controlled way. City of Helsinki Environment Centre took water samples once a week to measure the impact of restoration work. The load of the solid substances was 915 kg and the load of total phosphorus 0.65 kg for three weeks.

The aim of this study was to monitor i) water quality to assess the load of solid substances and nutrients to the River Vantaa and ii) to measure temporal and spatial variation of the water quality and quantity. Information will be used in choosing further restoration methods and most effective areas to make restoration. Water quality will be monitored again after future restoration projects.

We measured the water quality during the periods 19th April 2010–6th October 2010 and 4th April 2011–11th January 2012. Temperature, pH, conductivity, oxygen, turbidity and water depth was measured every 10 minutes with a high-frequency measuring equipment (YSI 6920 sonde). In addition, water samples were taken from different parts of the brook and analyzed in accredited laboratory.

Water temperature, oxygen and pH fluctuated diurnally: temperature and pH values were highest in the evening and oxygen in the afternoon. The diurnal fluctuation was biggest in June for the temperature (6 °C), pH (0.2), and oxygen (2–3 mg/l). In Longinoja there were no problems with low pH or oxygen. Turbidity and nutrient concentrations were very high time to time. Also hygienic quality was often poor.

The water discharge was at its highest in spring due to the melting snow. The discharge increased rapidly after heavy rains in summer, after which the water level lowered in a couple of hours. December 2011 was exceptionally rainy and the discharge was at the high level during the month. The discharge was the main explaining factor of the total loading (monthly average rain explained 75% of the monthly load of total phosphorus). Therefore, future restoration methods in Longinoja brook should be designed to retain stormwaters in the catchment area before entering into the channel, which would decrease the erosion of the brook banks.

Two-way coupled atmospheric-hydrological model and its application in Rio Grande basin, Brazil

Fábio F Pereira and Cintia B Uvo

Department of Water Resources Engineering, Lund University, Sweden,
email: Fabio.Pereira@tvrl.lth.se, Cintia.Uvo@tvrl.lth.se

Anthropogenic activities have modified land cover to obtain food and other essentials for thousands of years, driving changes in ecosystems and environmental processes at local, regional and global scales. Ecosystems and climate interact with each other on a time scale that varies from seconds to millions of years through exchange of heat, moisture, gases and momentum, so that effects of the ecosystem on climate and of climate on the ecosystem create a feedback loop. Because of this feedback, the estimation of the impacts of changes in the ecosystem on the local and regional climate and hydrology requires the two-way coupling of a regional atmospheric model and a hydrological model.

This work describe the two-way coupling performed between the regional atmospheric model BRAMS (http://www.cptec.inpe.br/brams/index.shtml) and hydrological model MGB-IPH (Collishonn et al., 2007). As a first step of the atmosphere-hydrology coupling, only the water balance variables were coupled (i.e. precipitation, evapotranspiration). However, further studies are ongoing in order to perform a full coupling which includes exchange of water budget with dynamics in land cover and soil features.

Differences in temporal and spatial scales between MGH-IPH and BRAMS were analysed. By default, MGB-IPH has a daily time step whereas BRAMS is applied with a few seconds per time step. So, values of accumulated rainfall over a day from the BRAMS were used to feed MGB-IPH. On the other hand, daily values of evapotranspiration from MGB-IPH were divided into the BRAMS time steps and distributed constantly over the day. This procedure was assumed as a daily loop for simulations. Differences in spatial scales were avoided by using the same grid size (10 x 10 km) in both models, in such way that effects of upscaling and downscaling were avoided.

The coupled system was tested for the River Grande Basin situated in south-eastern Brazil by comparing results from the BRAMS with results from the coupled system (BRAMS-MGB) for the same period, with the same input data.. Both of runs were performed over a period of 30 days. Outputs from the runs were, furthermore, compared to satellite images. The results showed that there is a visible positive impact of better resolved surface hydrology of BRAMS-MGB in the formation of clouds and precipitation over the Rio Grande basin. It also indicates that further efforts are required for better consideration of the land phase of the water cycle in weather forecasting.

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Estimation of hydraulic conductivity of the sandstones in the central Baltic Artesian Basin

Eleonora Pērkone[1], Ilze Klints[2], Tomas Saks[1], Aija Dēliņa[1], Jānis Bikše[1], Jānis Jātnieks[1], Baiba Raga[1], Inga Retiķe[1]

[1]Faculty of Geography and Earth Sciences, University of Latvia, Alberta Street 10, Riga, Latvia, e-mail: eleonora.perkone@lu.lv
[2]VTPMML, Faculty of Physics and Mathematics, University of Latvia, Zellu Street 8, Riga, Latvia, e-mail: ilzestankevica@inbox.lv

Aquifer fluid conductivity properties describe ability of sediments to transmit groundwater, and consequently govern the groundwater flow. Studies and knowledge of hydraulic conductivity (K), transmissivity and storativity for the particular aquifer is of great importance for hydrogeological problem solving process.

This study presents the results of the comparative study between hydraulic conductivity, grain size distribution, sediments lithology in the lower Devonian Emsian stage, middle Devonian Eifelian, Givetian stage and upper Devonian Frasnian stage clastic sediments in the central part of the Baltic Artesian Basin. The aim of this study was to find characteristic hydraulic conductivity values for each aquifer based on aquifer grain size distribution and lithology on the one hand and pumping test results one the other.

Pumping test results provide a range of at least two orders of hydraulic conductivity values for each aquifer. To characterize the typical values for each aquifer and further subdivide each aquifer into regions of different hydraulic conductivities, pumping test results were correlated with grain size distribution and sediment lithology. As a limiting factor for the hydraulic conductivity and grain size distribution correlation in the sandstones were chosen the fraction of the fine particles with the size less than 0.05 mm. The correlation of hydraulic conductivity and grain size distribution was carried out by comparing the <0.05 mm fraction and respective hydraulic conductivity values. The results suggest that grain size distribution in general does not correlate with conductivity obtained from the pumping tests. Calculated values in some cases differ from obtained for some units (1 – 3 m/day) but in some cases more than two times, which is connected with uncertainty of existent data and imperfections of the calculation methods. Correlation with the sediments lithology of the aquifer (as described in boreholes) shows better results and allows to subdivide the aquifer into two or more clusters of typical K values. Correlation of the grain size and hydraulic conductivity provided a range of the average hydraulic conductivity values for each aquifer.

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Use of constructed wetlands for treating runoff from peat extraction areas

Heini Postila[1], Satu Maaria Karjalainen[2], Kaisa Heikkinen[2], Jaakko Saukkoriipi[2], Minna Kuoppala[2], Mika Visuri[2], Raimo Ihme[2] and Björn Klöve[1]

[1]Water Resources and Environmental Engineering Laboratory, Department of Process and Environmental Engineering, University of Oulu, P.O. Box 4300, FIN-90014 Oulun yliopisto, Finland, e-mail: firstname.lastname@oulu.fi

[2]Finnish Environment Institute (SYKE), P.O. Box 413, FIN-90014 Oulun yliopisto, e-mail: firstname.lastname@ymparisto.fi

The aim of the study was to find out how wetlands established to ditched peatlands, can be used for treating runoff derived from peat extraction areas. Runoff may contain regionally harmful loads of impurities e.g. phosphorus, nitrogen and suspended matter.

The study included six drained wetlands, which were examined for e.g. the hydraulic properties of peat, vegetation, peat thickness, the degree of peat humification, and the mineral concentrations of peat. The wetlands were also monitored for their capability to remove e.g. nutrients, iron and suspended matter from the runoff. Sampling was carried out by taking water samples from incoming and outgoing water.

The results showed that wetlands established to ditched peatland areas, can purify peat extraction runoff. The wetlands retained especially inorganic nitrogen and suspended matter from the runoff. The leaching of phosphorus and iron was however detected to be a problem in some of the studied wetlands.

When planning wetlands for water purification purposes to ditched peatlands, special attention should be paid to the geological properties of peat (e.g. P, Fe, Al, Mg, Ca, Mn) and the peat thickness in relation to the depth of the ditches.

Hydrologic regime restoration in the Dovinė River basin, Lithuania: Modelling scenario approach

Arvydas Povilaitis

Aleksandras Stulginskis University, 53361 Kaunas-Akademija, Lithuania, e-mail: arvydas.povilaitis@asu.lt

Flow regime is generally considered to be the primary process driving the river ecosystem. However, during the second half of the 20th century, large-scale agricultural expansion posed a threat to the natural water conditions in the Dovinė River basin, Lithuania. The water regime of this river has been altered significantly: sluice gates have been built at the outlets of some lakes, and natural peatlands have been reclaimed for agriculture. To improve the situation, an integrated project was carried out at basin level with the aim of producing a management and restoration plan for the basin.

The Dovinė River basin covers an area of 588 km2. The basin consists of a network of streams and a number of through-flowing lakes (Dusia 23 km2, Žuvintas 9 km2, Simnas 2.4 km2, and Amalvas 2 km2). It holds one of the most important and currently most threatened nature reserves of Lithuania: the Žuvintas Lake. Before river regulation took place, the river valley flooded each spring. During the floods, organic and inorganic material accumulated on the flood plain, which was used as meadows. Since the regulation, the flood plain has become much smaller and most of the transported sediments and nutrients now accumulate in the lakes. Obviously, the change in the hydrological regime has had a negative impact on the biodiversity of the Dovinė River basin and on Lake Žuvintas in particular.

To analyse the complex Dovinė basin with its wetlands and lakes the physically-based spatially distributed hydrological model SIMGRO (SIMulation of GROundwater and surface water levels) was used. It simulates the flow of water in the saturated zone, the unsaturated zone and the surface water. The model gave a proper basis for making decisions about feasible measures. Therefore, different scenarios including the removal of sluice gates, blocking of drainage ditches and clear-cutting of bushes and trees on wetlands were analysed to ascertain the impact of changes on the river regime and on the water levels in lakes and groundwater condi¬tions in the adjacent wetlands.

Simulations revealed that restoring the water dynamics and flow pattern of the Dovinė river to its original state, by removing the sluice gates, appeared to be impossible: it would result in an undesirable fall in the water level of the lakes and negative impacts on bank stability and the aquatic conditions. Therefore, partial naturalization of the flow might be achieved by reconstructing the sluice gates and installing specially designed overflow spill weirs along with fishways. Also, a good measure for improving the hydrological conditions is to block drainage ditches and remove bushes and trees from the wetlands. The effect of the measures on the river flow is that the blocking of ditches decreases the flow whereas the other measures increase the flow. For all the measures considered, the flow in the river was compared with the reference situation. In this way the measures were also evaluated for the change in river flow: the average, high, low and peak flows.

Based on the results of modelling scenario relevant measures were proposed to the Dovinė river basin management plan and subsequently implemented into practice. Their effectiveness on the improvement of hydrological conditions has been monitored. More details on the implemented measures and their usefulness will be shown and discussed in the presentation.

Sustainable use and protection of groundwater resources in delta areas: the fresh maker and fresh keeper

Klaasjan J. Raat[1], Gertjan Zwolsman[1], Ate T. Oosterhof[2] and Jan Willem Kooiman[1]

[1]KWR Watercycle Research Institute, PO Box 1072, 3430 BB Nieuwegein, The Netherlands, e-mail: klaasjan.raat@kwrwater.nl
[2] Vitens Water Supply Company, PO box 1090, NL-8200BB Lelystad, The Netherlands

In coastal areas, fresh groundwater resources are limited and when exploited they are often subject to intrusion of brackish and saline groundwaters. Two technological remedies against these problems are presented: the fresh maker and the fresh keeper. These concepts make it possible to preserve and even enlarge fresh groundwater reserves, allowing sustainable groundwater abstraction. Interception of brackish water is key to these concepts and, when treated with reverse osmosis (RO), this water forms an additional fresh water source.

Salinization of water wells can be prevented by simultaneously abstracting upper fresh water and lower brackish groundwater, preventing upconing of brackish groundwater into the fresh water layer. This so-called fresh keeper concept was successfully applied at well field Noardburgum, the Netherlands (Vitens Water Company). The abstracted brackish water is treated with RO and used as an additional water source, and so the once abandoned well now produces more fresh water than the original volume.

The fresh maker protects thin fresh groundwater lenses by interception of underlying brackish water using horizontal abstraction wells or drains. Combination with artificial recharge during the wet season will even increase the fresh water storage, thereby enlarging the amount of fresh water available for crop irrigation in the growing season. The use of horizontal wells or drains makes the technique applicable in thin aquifers. A field scale pilot of the fresh maker is planned in autumn 2012.

Groundwater chemistry changes in Gauja aquifer in depression cone in Riga region, Latvia

Baiba Raga [1], Andis Kalvans [1], Aija Delina [1], Inga Retiķe[1] and Eleonora Pērkone[1]

[1]University of Latvia, Faculty of Geography and Earth Sciences, Alberta Street 10, Latvia, e-mail: baiba.raga@lu.lv

Gauja aquifer is one of the main drinking water resource for water supply in Latvia. This aquifer belongs to upper Devonian and has good properties for groundwater extraction: it has high permeability and is widely spread. The excessive water extraction in Riga causes sharp and significant lowering of the piezometric surface. The maximum decline of groundwater level was observed in 1972, when it was 17 m lower than the average. Beginning with the end of 80's, decreased the volume of water usage and the regeneration of water table started.

This study uses long – term monitoring data that furnishes information about a 50 year period. Data on major ions and piezometric surfaces from 17 monitoring stations is analysed. Based on the piezometric surface decline, territory was dived into three zones - central, intermediate and periphery. Volume of extracted water in central part was also calculated, to determine the approximate amount of different types of water that recharge the Gauja aquifer. And to define source of different oring water mixing curves between various type of water were made and hydrogeological model was used to determine the flow and piezometric surface changes in three periods: in 1950., 1980. and 2000.

It was found out that the source of different water types in central part are from the Salaspils aquifer. That indicates the high values of SO_4^{2-} which worsens the quality of water in the Gauja aquifer. But these changes in the Gauja aquifer show up with time lag around 10 years. In areas where water table decline wasn't so significant, the recharge of the Gauja aquifer comes from deeper aquifers like Arukila un Burtnieki. In some areas the water source is with high Cl- concentration, like in monitoring station „Jugla", where concentration of chloride has increased. Also the first signs about water composition changes show up very quickly, but the return to the natural situation is relatively slow, because the growth of SO_4^{2-} ion in the Gauja aquifer is still observed in the latest samples. Despite that Riga is lying near the sea, the lowering of water table in Gauja and near aquifer hasn't induced intensive intrusion of sea water.

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Quantification of daily dynamics of stream flow component using End Member Mixing Analysis in a small glacier dominated alpine watershed

Kazi Rahman[1], Emmanuel Castella[2], Chetan Maringanti[1] and Anne-Laure Besacier-Monbertrand[2]

[1]Envirospace Lab, University of Geneva
[2]Aquatic biology Lab, University of Geneva

In order to identify and quantity the potential geographic sources that contributes stream runoff, water samples were collected from 9 different tributaries in a small glacier dominated forested catchment from central Switzerland. The study conducted in a 7.09 km2 watershed where 43 % land cover consists of glacier and seasonally inaccessible. In situ measurements were done for temperature, electric conductivity and turbidity of water at different temporal scale. Mass spectrometry was done to analyzed silica and sulfate along with chlorine. Three different sources were identified based on their physio chemical characteristics they are glacier melt water, quick routed surface runoff from snow and precipitation, and slow routed ground water. Principal component analysis was performed in order to reduce their dimensionality independently in two hydrological years. End member mixing analysis was done both at morning and evening to understand the daily variation of runoff component at different weather condition. Our study suggests that glacier melt component highly varies from morning to evening and the phenomenon observed quite strong during the raising period of the melt season [until August] rather than recession period. Information gained form this study will be used to analyzed the ecological connectivity of specise living the the watershed their dependancy of the type of water as a future step.

Keywords: EMMA, PCA, Glacier melt, Snow melt

On climate prediction: performance evaluation of RCMs

Arun Rana[1], Shilpy Madan[2] and Lars Bengtsson[1]

[1]Department of Water Resources Engineering, LTH, Lund University, Box No. 118, Lund 22100, Sweden, e-mail: arunranain@gmail.com and lars.bengtsson@tvrl.lth.se
[2]Department of Mathematical Statistics, Lund University, Box No. 118, Lund 22100, Sweden, e-mail: hishilpy@gmail.com

In a changing climate scenario it is important to study how different components of a climate system may change. Many impact sectors, particularly relating to flooding and water resource management techniques, variation in precipitation intensity and amount are of much importance (Jones and Reid, 2001). Role of different climate model in studying these impacts is far beyond doubt. Climate modeling has evolved many folds since their introduction in 1960s to incorporate different aspects of earth system into modeling and improving their performance. This study is aimed at evaluating performance of different RCMs over Europe derived from GCMs by means of statistics of precipitation over Goteborg, Sweden.

Performance evaluation in prediction of precipitation is done using RCMs including Ensemble driven by two GCMs namely HadCM3Q0 and ECHAM5r3 with that to the observed values over Goteborg. Three datasets were used for the same purpose. The first set incorporated the daily mean precipitation data from 01 January 1961 to 31 December 2009. The second set is derived from this by computing total precipitation in each month for each year, i.e., from January 1961 to December 2009. Lastly, the third set accounts for annual precipitation values, i.e., from 1961 to 2009. We have assessed the statistics of data obtained from these models and compared them with those of the observed data to comprehend if these models can be used for significantly predicting future climate change and their application in hydrology.

Principle Component Analysis is used to analyze which of RCMs best track the observed precipitation statistics and can be relied upon for climatic predictions of 21st century. It was further supported by other techniques including comparison in regard to maximum daily, two-day, three-day and seven day maximum. We have used 99th percentile of daily precipitation data as our threshold value and computed the frequency and intensity of exceedances more than 20mm per day. These values were then used to fit a Poisson distribution and Generalized Extreme Value distribution respectively. We have also performed Fourier transform of the monthly precipitation data and Man Kendall Trend Analysis test was used to detect any significant trend in data. Lastly, we have compared the inter-annual relative change percentage of our sampled data.

The results obtained point towards the usefulness of these very high resolution regional climate models in studying various observed trends. PROMES from HadCM3Q0 comes close to the frequency spectrum of the observed data. It also follows inter annual relative change percentage of Goteborg precipitation closely and came closest to the two-day, three-day, seven-day-maximum averages of the observed data. Man Kendall test indicated no significant trend both in observed data and model simulations. The number of exceedances above a threshold value accepted the Poisson distribution hypothesis and the mean value of PROMES data was in accordance with the observed. PCA also indicated the fact that PROMES came closest to the observed and all these results point towards achieving the RCM-PROMES that best describes the observed data statistics among the models used in study. Results also indicate that there is no one model which could be relied on correct predictions but significant improvement have taken place by incorporating different aspects of earth systems in modern day climate models.

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Valuation of nitrogen retention as an ecosystem service at catchment scale

Katri Rankinen[1], Kirsti Granlund[1], Randall Etheridge[2] and Pentti Seuri[3]

[1]Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland, e-mails: katri.rankinen@ymparisto.fi, kirsti.granlund@ymparisto.fi
[2] North Carolina State University, Campus Box 7625 Raleigh, NC 27695, e-mail: jretheri@ncsu.edu
[3]MTT Agrifood Research Finland, Lönnrotinkatu 5, FIN-50100 Mikkeli, Finland, e-mail: pentti.seuri@mtt.fi

The concept of ecosystem services emerged scientifically fifteen years ago. Different typologies of ecosystem services cover the broad range of services, such as providing food, fiber, shelter and available habitats, regulating carbon, water and pollination, and creating opportunities for recreation, religion and aesthetics. Ecosystem services can be described as the benefits people obtain from ecosystems, the "services of nature".

In this work we studied impact of land management scenarios on nitrogen retention as water purification services at catchment scale. The set of scenarios are based on changes in land use that arise from greening measures included in the new CAP proposal, and other water protection and agricultural policy measures. The set of scenarios include: increased area of set aside land, decrease of nitrogen fertilization, wintertime crop cover on fields, crop diversification and organic farming. As political measures usually affect not only positively but sometimes also negatively, we aim to provide quantitative information concerning the impact of various measures on the ecosystem service water purification. The monetary valuation of nitrogen retention by freshwater ecosystems is based on purification efficiency and construction costs of artificial wetlands.

We calculated nitrogen retention in two agricultural catchments (Lepsämänjoki and Yläneenjoki) by INCA-N model (Wade et al. 2002). It is a dynamic, process-based and semi-distributed model to calculate N loads from terrestrial environment to the river and further to receiving waters. Lepsämänjoki catchment is a tributary of the Vantaanjoki river basin, which discharges to the Baltic Sea at Vanhankylänkoski in Helsinki. The area of the Lepsämänjoki catchment is 214 km^2 and lake percentage is 3. Fields cover 23% of the catchment area the rest being forest. Main crops are spring cereals (16% of the catchment area). In the upper areas of the catchment there is cabbage cultivation, which typically has very high positive N balance. The Yläneenjoki catchment is located in south-western Finland. The area of the catchment is 233 km^2 and lake percentage is 0. Fields cover 27% of the area, main production line being animal husbandry (pigs and poultry).

When comparing catchments with each other nitrogen retention as water purification service provides more value at Yläneenjoki catchment than at Lepsämänjoki catchment. When comparing measures with each other, some really proved to have a negative value. Some measures, like set aside, had a high positive value when calculated per area, but at catchment scale the value remained low because of small area of implementation.

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Explaining the recent changes in agricultural nutrient loading in Finland

Katri Rankinen[1], Petri Ekholm[1], Hannu Rita[2], Heidi Sjöblom[1] and Ljudmila Vesikko[1]

[1]Finnish Environment Institute, P.O. Box 140, FI-00251 HELSINKI, Finland, e-mail: katri.rankinen@environment.fi
[2]University of Helsinki, P.O. Box 27, FI-00014 UNIVERSITY OF HELSINKI, Finland, e-mail: hannu.rita@helsinki.fi

We examined the fluxes of phosphorus (P) and nitrogen (N) carried by 22 Finnish rivers into the Baltic Sea in 1985–2006. The proportion of agricultural load (including natural background) was estimated by subtracting from the total river flux the reported point-source load, and the estimated loads caused by forestry practices and the sparse population. Temporal and regional patterns in the agricultural load was analysed by using available data on (1) catchment characteristics (lake and field percentage, runoff, and the proportion of peat lands and organic fields), (2) field use (proportion of crops, grassland and set-aside) and (3) intensity of agricultural production (soil-test P, nutrients in manure). For N, atmospheric deposition and soil temperature were also used as explanatory variables. The statistical method employed took into account for multicollinearity of the explaining variables.

The specific P and N loads for agriculture derived from statistical models were at the same level as those estimated elsewhere for Finnish agriculture. After accounting for runoff and lake percentage of the catchment, 83% of agricultural P load was explained by the field percentage and the level of soil test P. A model including runoff, lake and field percentages and soil temperature, explained 90% of variation in agricultural N load. This finding suggests that the recently found increase in agricultural N load may be partly attributable to increased mineralisation enhanced by increased soil temperature.

Silica and stable isotopes indicating groundwater surface water interactions at Lake Pyhäjärvi catchment area, SW Finland

Anne Rautio and Kirsti Korkka-Niemi

Department of Geosciences and Geography, University of Helsinki, P.O. Box 64, FI-00014 University of Helsinki, Finland, e-mail: firstname.lastname@helsinki.fi

Silica (SiO_2) concentration and stable isotopic composition has been used to indicate the groundwater discharge from aquifers into the rivers and Lake Pyhäjärvi and to evaluate the proportion of groundwater in the rivers and the lake inshore in one year monitoring programme.

The mesotrophic Lake Pyhäjärvi has a surface area of approx. 155 km^2, a perimeter length of 88 km, a mean depth of 5.5 m and drainage basin area of 616 km^2. There are two major rivers discharging into the lake and one outflowing river. There are Quaternary esker aquifers connected to north and northeastern side of the lake. The groundwater dicharge fluxes into the lake of the order of 10^{-3} and 10^{-4} cm s^{-1} were measured using seepage meters (Rautio & Korkka-Niemi 2011). There are two water intake plants: Kauttua in the northernmost corner and Honkala on the eastern shoreline of the lake.

SiO_2 and isotope ratios were analysed from 188 groundwater, inshore water and surface water samples. In SiO_2 concentrations and isotope ratios, there is a major difference between groundwater ($\delta^{18}O$ about -12‰, δ^2H about -86 ‰ (VSMOW)) SiO_2 about 10 ppm) and surface water. The isotope composition and SiO_2 concentrations were quite constant ($\delta^{18}O$ about-7.4‰ and δ^2H about -59.7‰ (VSMOW) and SiO_2 mean 0.97 ppm) in lake water. In rivers the isotope composition and SiO_2 concentrations varied more (($\delta^{18}O$ -13.7-(-9.4)‰ and δ^2H -97.1-(-67.3)‰ (VSMOW) and SiO_2 1.89-7.72 ppm).

There are differences between two incoming rivers. River Pyhäjoki has higher baseflow (78%; Wiebe 2012), observed also as higher SiO_2 concentration. Stable isotopic composition is more like groundwater and there is small seasonal variation in the values. In river Yläneenjoki (baseflow 65%; Wiebe 2012) spring thaw (snow melt) can be seen more clearly and lower stable isotope values and smaller SiO_2 concentrations can be observed. SiO_2 concentration in river water and groundwater discharging into the lake diminish rapidly after reaching the lake. SiO_2 concentration and stable isotopic composition in the lake is very stable throughout the year. According to isotope mass balance calculations and SiO_2 concentrations the water from Kauttua water intake plant is 70- 100 % lake water depending on well distance from the lake shoreline.

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Calculation methods of environmental flow for Estonian rivers

Alvina Reihan[1], Elina Neemre[2] and Rain Elken[3]

[1]Environmental Engineering Institute of Tallinn University of Technology, Ehitajate road 5, 19086 Tallinn, Estonia, e-mail: alvina.reihan@ttu.ee
[2]e-mail: elinaneemre@hotmail.com
[3]e-mail: rain.elken@keskkonnainfo.ee

According to European Union Water Framework Directive (WFD) it is necessary to achieve the *good status (GS)* of watercourses (surface waters) by year 2015. GS means both good *ecological status* (GES) and *good chemical status* (GCS). To achieve the objective and maintain the natural ecosystem people have to recognize the importance of flow regime and river regulation (fragmentation), for this it is necessary to ensure *environmental flow* in rivers. There is no worldwide agreed definition of environmental flows and Estonia has not yet ascertained the definition and calculation methods of the environmental flow.

In Estonia many rivers are regulated and anthropogenically affected by dams or with other impoundments, which causes great effect especially on valuable fish communities (like salmonids). In general, environmental flows can be ensured by regulation of bypass mechanisms of dams and channels. It can be also done through specific allocation policies and through land-use management. However, most dams are destroyed in Estonia and no one monitors their status. Therefore, it is of a great important to ensure both self-cleaning capacity and health of riverine ecosystems below the dam. As there is no confirmed definition in the world, the research considers most widely and frequently used definitions in the European countries. The objective of the paper is firstly to define the term of environmental flow. In Estonia the flow in rivers had to be ensured previously by calculating sanitary minimum flow (Q_{san}=$Q_{30d95\%}$), but it is extremely low flow for achieving the good status of rivers. In addition, such a low flow can create isolation through the fragmentation that in turn can decline water biodiversity. Therefore, the next task of the study is an assessment of different methodologies for environmental flow calculations for dissimilar river regimes and ecosystems in river basins. From many calculation methodologies five hydrological methods were tested, where from the three suitable ones were selected.

As environmental flow is always a compromise between water use for “development” and water for nature, the authors proposed the most suitable methods for Estonian conditions: Tennant for salmon rivers ; Q95 (30-days mean flow with 95% exceedance probability) and 7Q10 (7-day low flow with 10-year returning period) for the rest rivers and for the regulated, mostly for the hydro power generation, rivers. Methods have also been in turn compared with previously used sanitary minimum flow. In an ideal situation environmental flow requirements will be written into Estonian legislation, provided and monitored by water managers and controlled by a government body with assistance from research organisations. For this reason, the theme of the paper is very important and actual.

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Evolution of groundwater chemical composition through Quaternary sediments in Latvia

Inga Retike[1], Baiba Raga[1], Andis Kalvans[1], Alise Babre[1], Aija Delina[1] and Eleonora Pērkone[1]

University of Latvia, Faculty of Geography and Earth Sciences, Albert Street 10, Latvia,
e-mail: inga.retike@lu.lv

The chemical composition of unconfined groundwater is influenced by all the processes that take part during their formation and water feeding conditions, which depend on site lithology, have a great importance. As the main replenishment of the Quaternary groundwater is precipitation it can have a significant role in making the unconfined groundwater chemistry. Groundwater chemistry mainly depends on the minerals present in layer of water-bearing rocks through which water moves. The most common Quaternary sediments in Latvia are till, silt, various coarse of sand, clay and peat. They differ in mineral composition and grain size distribution which affect groundwater chemistry as well. In this research chemical composition of rainwater and unconfined groundwater in Quaternary sediments is studied to find out the role of different water-bearing rocks and rain water chemistry in making unconfined groundwater composition.

In this study data about trace element content, major ion chemistry, stable isotope signals (groundwater only) and physical parameters in groundwater and rain water from Latvian Environment, Geology and Meteorology Centre databases, project ”Agricultural Influence on Groundwater in Latvia”(Gosk at al., 2006) and European Social Fund project „Establishment of interdisciplinary scientist group and modelling system for groundwater research” are used. Quaternary groundwater chemical composition maps of Latvia was carried out by using software „HifiGeo” and „Piper” charts that represent the major ion ratios was carried out by using software „R”. Chemical composition modelling was carried out using Phreeqc Interactive 2.18, but data analysis was made using software “R”, “Medcalc” and “Minitab 16”.

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Climate change impacts and the adaptation measures in the Finnish water industry

Jari Rintala, Sanna Vienonen and Mirjam Orvomaa

Finnish Environment Institute, P.O. Box 140, FI-00251 Helsinki, Finland,
e-mail: jari.rintala@ymparisto.fi, sanna.vienonen@ymparisto.fi,
mirjam.orvomaa@ymparisto.fi

The current status and quantity of surface and groundwater resources are mainly good in Finland. Groundwater reservoirs or artificial groundwater provide 66 percent of the national water supply as only the largest cities use surface water. Five million Finns have access to the water distribution network and the daily use is in average 130 liters/person. Climate change will impact all areas of the water industry. Key impact factors are more frequent and severe weather conditions: storms, heavy rainfall, flooding, and droughts. These extreme weather events can jeopardize the quality and availability of water sources, and lead to the need of increased water treatment or even interrupt water distribution.

Climate change impacts will affect the water supply acutely and thus water works should be in the forefront in adapting to a changing climate. There have been several significant distractions in local water distribution during the past ten years, which have demonstrated the vulnerability of the existing means, and thus emphasized the need to improve water suppliers' adaptation measures in hazardous situations. Adaptation measures for water works were outlined in our resent study. Precautionary measures include risk assessment, preparedness plans for water works, the planning of flood control and conservation of groundwater basins.

Essential adaptation measures include positioning the intake wells so that no rainfall-discharge or surface water can directly flow into the wells even during flooding or heavy rainfall. The time of seepage must be adequate for all wells, especially bank filtration wells, to ensure water quality. Water quality must moreover be ensured by adequate control and treatment facilities including disinfection systems as well as standby batteries at the water intake plants. Furthermore, the risk of wastewater overflow discharge needs to be minimized by positioning wastewater facilities, especially pumps, outside of groundwater areas and flood risk areas. The water yield of smaller groundwater bodies should be evaluated in the perspective of prolonged droughts.

The above mentioned means play an important role in adapting to climate change, however, the adaptation measures should be further developed, and more information on groundwater resources is needed. Cooperation between water works should be emphasized as it is particularly beneficial during hazardous situations for e.g. by enabling the access to alternative water supply sources.

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Nitrate concentration changes in stream of Lithuanian karst zone within the context groundwater-surface water interaction

Aurelija Rudzianskaite

Water Research Institute of Aleksandras Stulginskis University, Parko 6, Vilainiai, LT-58102 Kedainiai district, Lithuania, e-mail: Aurelija.Rudzianskaite@asu.lt

Eutrophication of freshwater environments represents a major threat to the ecological health of surface water in agricultural catchments. High nutrient concentrations, caused by direct inputs into the surface water or indirect contributions via groundwater pathways, can result in excess algae growth. The transport and transformation of nitrate between groundwater and surface water may influence the success of restoration measures to improve stream and groundwater ecological conditions (Krause et al., 2009). The Lithuanian karst zone has specific geomorphological conditions. Here the sinkholes that formed in the course of karst processes create suitable conditions for surface water and pollutants to get into the subsurface water.

The bigger rivers have more intensive mixing processes in the flow and receive runoff from greater areas, while quality of stream is under immediate impact of local factors and distinguished impact of particular factors in the catchments (Gaigalis and Smitiene, 2004).

This study investigates the change of nitrate concentration in the small stream at the groundwater–surface water interaction.

The studies were carried out in moraine sandy loam and peat soils of Lithuanian active karst zone. The site is situated at the headwater of stream G-1 (tributary of the Apascia, area 1.63 km^2). Active karst processes develop in these gypsum layers. The layers of gypsum-dolomite occur at 5-10 m depth from the soil surface (gypsum layers occur deeper) of the study area.

The quality of groundwater was observed in three wells. The well 1 (depth 6 m) was arranged in a sandy loam soil, in a drained area at a distance of 1 m from the streambed; the well 2 (depth 4 m) was arranged in a peat soil, between the stream G-1 and a sinkhole. The sinkhole covered with peat is approximately 10-15 m in diameter, over grown with reeds, often waterlogged by surface water. The well 3 (depth 1.5 m) was arrange in this sinkhole. When stream catchments was drained, water quality and discharge was measured in the drainage system (area 4 ha) the outlet of which is at 10 m distance from the well 1. The area of the drainage system is over grown with perennial grass. Water quality of the stream was measured nearby the well. Water samples were collected once per month in all study places.

Nitrates leached out in drainage influence the small stream water quality. Large amounts of nitrogen are leached through drains; which determines the concentrations of this element contained in stream water. When the ground water level fluctuated at a distance less than 120 cm from the ground surface, the strongest correlation of the change in nitrate concentration in the groundwater and stream water was identified. With the decrease of the ground water level, the change of nitrate concentration in the water was less related to the stream water quality. In the well 3 located in the sinkhole, the nitrate concentration was higher than in the other wells.

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Trends in DOC export from Finnish rivers to the Baltic Sea between 1975 and 2010

Antti Räike[1,3], Pirkko Kortelainen[1], Tuija Mattsson[1] and David N. Thomas[1,2]

[1]Finnish Environment Institute (SYKE), P.O. Box 140, FI-00251, Helsinki, Finland.
[2]School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey. LL59 5AB. U.K.
[3]Marine Research Centre, Finnish Environment Institute (SYKE), Mechelininkatu 34a, P.O. Box 140, FI-00251 Helsinki, Finland, e-mail: antti.raike@ymparisto.fi

Over the last two decades dissolved organic carbon (DOC) concentrations have been frequently measured as increasing in freshwaters of the northern hemisphere. There has been much debate on how climate change will affect soil organic carbon and whether or not the vast carbon reserves in northern soils will turn from a sink into a net carbon source. However, presently there is no clear evidence, that increasing concentrations will be reflected in DOC export to coastal waters. We studied riverine DOC export from Finnish catchments to the Baltic Sea between 1975 and 2010. To separate the influence of flow from other drivers we estimated trends of both flow normalised and non-normalised DOC export. Runoff did not show any overall annual trend, although winter flow showed slight increases in northern Finland. Inter-annual variation in runoff was the major driver affecting the changes in DOC export. DOC fluxes showed some increase during the winter months, but we could not find any evidence of an overall annual increase in DOC export to the Baltic Sea since 1975.

The extraction of sedimentary deposits in South Ostrobothnia's lake region

Anna Saarela[1]

[1]Seinäjoki University of Applied Sciences, School of Agriculture and Forestry,
Tuomarniementie 55, FIN-63700 Ähtäri, Finland, e-mail: anna.saarela@seamk.fi

The aim of the European Commission is to substantially increase renewable energy usage in Europe by the year 2020. Renewable energy plays an essential role in improving local energy production and mitigating climate change. There are many sources of renewable energy and it is possible that organic sedimentary deposits could be used for energy.

The ultimate reason for eutrophication is the increase of nutrients in water; mainly phosphorus (P). Part of the nutrients originates from the catchment area and part is result of the process in water. By reducing the oxygen demanding organic sediment layer it could be possible to improve the water quality and thus water ecosystems.

The aim of the project was to survey the extraction of organic sedimentary deposits. The themes examined were: 1) Define the composition of the sediment in order to find out whether the material is organic or mineral, 2) Define the chemical composition of the sediment concerning mainly heavy metals, 3) Evaluate the impact on the water quality, 4) Assess the technology for harvesting/collecting sediment, 5) Authorization for the operation and 6) Other possibilities for sediment usage.

In June 2011 six (6) samples of sediment were taken from the lake Alajärvi (n=5) and lake Hankavesi (n=1) in South Ostrobothnia. The proportion of organic material in the sediment samples ranged from 5 to 35 per cent. Moreover, environmentally hazardous substances were examined in the samples. Most of the heavy metals examined were below the threshold values. However, the dry matter levels in lake Alajärvi for Arsenic (As = 34 mg/kg: threshold 15 mg/kg) and Cadmium (Cd = 0,9 mg/kg: threshold 0,5 mg/kg) were above the thresholds, also in lake Hankavesi the Cadmium level was above the threshold (Cd = 0,8 mg/kg).

In Hankavesi cove there was an experimental dredging in late August where the sediment was collected using a floating excavator. The visibility in the body of water was measured at four (4) different points twenty meters apart. This started the day before dredging, and was repeated again right after dredging and every two (2) days until the visibility had returned to its original state; this took nine (9) days. Also a water sample was taken five (5) days after the experiment. Both the muddiness and the solid matter in the water body were within the normal range. According to the report, the dredging caused no long term harm to the water quality.

Possible uses for the organic sediment could be: the material's direct burning or its use for biogas production. The calorimetric heating value (SFS-EN 14918) of the sampled material was 14.2 MJ/kg which is considerably lower than that of peat (22.3 MJ/kg). Integrated into the management of badly affected waters, burning the sediment or using it for methane production, could be a way to handle what would otherwise be waste material. Another possibility is to use it for land fill or for soil improvement. The sampled sediment was quite poor in nutrients but could improve inorganic soils by increasing the organic matter in it. The amount of heavy metals or other hazardous substances in the sediment samples were below the threshold of fertilizers or soil improvements.

Removing phosphorus from ditch water with Ca-Fe oxide granules

Egle Saaremäe[1], Martin Liira[2], Morten Poolakese[1] and Toomas Tamm[1]

[1]Institute of Forestry and Rural Engineering, Estonian University of Life Sciences, Kreutzwaldi 5, Tartu 51014, Estonia, e-mail: egle.saaremae@emu.ee, toomas.tamm@emu.ee, morten.poolakese@emu.ee
[2]Department of Geology, University of Tartu, Ravila 14a, Tartu 51014, Estonia, e-mail: martin.liira@ut.ee

Agriculture has been found to be the largest anthropogenic source of plant nutrients enhancing eutrophication of open water bodies. It appears that improved nutrient retention near the polluters, e.g. agricultural point and nonpoint sources may play an important role in reducing the nutrient load in larger water bodies.

Phosphorus (P) is one of the nutrients causing eutrophication. The Water Framework Directive [2000/60/EEC] in Europe assesses three ecological statuses of water bodies: high, good and poor, and aims an objective to achieve status "good" in all water bodies by the year 2015. This emphasizes the need for as simple as possible and environmentally friendly methods to increase nutrient retention not only expanding the area covered with wetland, but also intensifying the retention processes. Hereafter, the term "Active wetland" is used distinguish a type of wetland where processes depend on human intervention, e.g. using phosphorus sorbing materials for phosphorus removal.

The aim of the present study was to investigate whether and how active wetlands in combination with management applying suitable sorbents for phosphate removal may reduce P load in agricultural drainage waters. In the present study, we investigated Ca-Fe oxide granules (Sachtofer PR) as a potential P sorbing material in the laboratory and in different field-scale experiments.

Laboratory batch experiments were used to measure the phosphorus removal potential of Ca-Fe oxide granules. The main removal mechanism was adsorption, which is a relatively slow process and therefore needs a long contact time between the solution and substrates. Our experimental results revealed that the phosphorus removal efficiency was from 38% to 50%. Also the chemical and mineralogical compositions of the materials were analyzed. The mineral composition of the Ca-Fe oxide granules is dominated by gypsum ($CaSO_4 \bullet 2H_2O$) which is more than 90% of the total amount.

In addition to the laboratory tests, we conducted small- and full-scale field experiments in Rahinge ditch in southern Estonia. The water quality of Rahinge ditch was monitored for one year. The total phosphorus and phosphate concentration ranged from 0,08-0,63 mg/l and 0,08-0,61 mgP/l, respectively, indicating a significant level of pollution. However this is not typical for Estonian conditions, but reflects a potential problem nearby large farms and intensive agriculture. Thus, this level of pollution may become the typical case when agricultural production increases in future. The small scale field experiment showed that phosphorus removal efficiency was 25-71%, depending on flow rate and contact time. The full-scale field experiment showed that phosphorus removal efficiency was only 4-25%, depending on contact surface, contact time and biological processes in the ditch. For example, it was found that the growth of algae on the surface of granules affected negatively on the retention processes. It was found that hydraulic aspects, i.e. contact time, flow velocity etc, together with sorbent properties will lead the proper design of the active wetlands.

Impacts of peatland forestry ditch maintaining operation on runoff water quality derived from sulphide-bearing sediments –how to avoid acid surges?

Tuomas Saarinen, Shahram Mohammadighavam, Hannu Marttila and Bjørn Kløve

Water Resources and Environmental Engineering Laboratory, University of Oulu, P.O. Box 4300 FIN-90014 Oulun yliopisto, Finland, e-mail: tuomas.saarinen@oulu.fi

Sulphide-bearing sediments were formed naturally during the warm Litorina period of the ancient Baltic Sea 7500–4000 years ago. Sulphide minerals are stable under anoxic conditions but, mainly because of intensive drainage for agriculture and forestry, they have been oxidized because of the drop of groundwater level (GW level). In a consequence of oxidation, soil pH decreases which increases mobilisation of several metals. It has been estimated that the metal leakage from Finnish AS soils is even 10-100 times higher than the effluent discharges from the entire Finnish industry. Thus there is urgent need of sustainable and cost-effective methods to prevent acidification.

This study focused on AS soils and peatland forestry drainage. The study was conducted during years 2010 and 2011 in north-western Finland in Luohuanjoki river basin (area 352 km^2), which is one of the tributaries of River Siikajoki, and known problems with acidity leaching from AS soils. Three study peatland forestry sites were selected based on mapping of potential location of sulphide-bearing sediments via geophysical maps and soil sampling. Firstly, the actual effects of peatland forestry on runoff water quality were studied by using both manual and automatical measurement data in both groundwater and main ditch in each area. Soil samples were taken for analyzing both the pH- and total sulphur concentrations in soil profiles of each site. Secondly, the potential effects were estimated using DRAINMOD model in the situations of different ditching depth, space and weather conditions. As input data of DRAINMOD, climatological data (e.g. temperature, precipitation, evaporation) were used from nearest weather station. In addition soil data (e.g. hydraulic conductivity, infiltration) and drainage data (e.g. depth and space of ditches) were used in each site.

Thickness of the peat layer was 80 cm, 160 cm and 90 cm in site 1, site 2 and site 3, respectively. Immediately below peat layer total sulphur concentration increased and was above 1 % in sites 1 and 2. Mean GW level was 55, 46 and 42 cm below ground in site 1, 2 and 3, respectively. Thus it was not observed any significant oxidation of sulphide minerals in soil during growing seasons 2010-2011. This has also evident according to pH measurements in groundwater where mean pH varied between 5.5-6.8, and never decreased below 4. In main ditch, minimum pH was 4.4, 4.8 and 5.5 in site 1, 2 and 3, respectively during high runoff in autumn. However, between TOC concentration and pH there was observed significant negative correlation rather than between SO_4^{2-} and pH which also indicates acidity derived from humic compounds of peat instead of sulphide oxidation. Simulated and observed GW level was well fitted together in 2010 (R^2=0.51-0.63) and in 2011 (R^2=0.50-0.71). According to the simulations, depth of the GW level was highly dependent on ditching depth and distance between ditches. For example in site 1, if space of the ditches was under 30 m and ditching depth over 120 cm, there was observed dramatic decline of GW level into mineral soil. This enables the oxidation of sulphides and potential leaching of metals. In current drainage of site 1 there was not observed decline of simulated GW level into mineral soil. However, according to simulation during dry summer 2006, GW level was dropped into mineral soil, which enables oxidation of sulphides. Results highlight that deeper ditches should be avoided when doing ditch maintaining operations.

Extreme rainfall events: Evaluation with different instruments and measurement reliability

Helmi Saidi[1], Marzia Ciampittiello[1], Claudia Dresti[1]and Laura Turconi[2]

[1] Institute of Ecosystem Study-National Research Council
[2] Research Institute for Geo-Hydrological Protection- National Research Council

The measurement of precipitation, particularly intense events, is extremely important for a range of applications including hydrology, water resource management, meteorology and climatology and civil protection. Each current instrument of measurements has a number of advantages and disadvantages.

With regard to extreme events, it is known that an intensity of about 1 mm/min (60 mm/h) already represents an extreme intensity. Under alpine conditions, like Lake Maggiore watershed, a precipitation event with intensity about 3 mm/min has occurred. Therefore the rain gauges in this region have to be able to measure in this and even in higher intensity ranges

The history of measurement instruments intercomparison in the case of rainfall measurements dates back significantly in the last centuries. Recently, the World Meteorological Organisation (WMO) had organized a field intercomparison of rainfall intensity Gauges which started on October, 1st 2007 at Vigna di Valle (Italy) and was concluded in May 2009.

Tipping bucket rain gauges are the most popular recording rain gauges used by many meteorological services generally providing relatively accurate point estimates of precipitation, especially for low-to intermediate intensity rainfalls. However, they overestimate rainfall value at low intensities (<50mmh-1) and underestimate rainfall at higher intensities (>100mmh-1) because of the rainwater lost during the movement of the bucket. A literature investigation has not yielded much information on the magnitude of underestimation of the rainfall recorded by the tipping-bucket rain gauge.

Our study analyses the data collected by the Italian automatic station in the Piedmont Region, which have been available since 1980. The historical extreme rainfall database consists of the annual series of precipitation maxima with durations of 5, 10, 15, 20, 30 and 45 min; 1, 2, 3, 6, and 12h; 1, 2, 3, 4, 5 days obtained from 4 stations situated in the watershed of Lake Maggiore. This study deals with basically automated tipping-bucket rain gauge CAE-PMB2, with a resolution of 0.2 mm and the collector area is 1000 cm2, and Bulk precipitation samplers in the same 4 stations, which allows to hold back more than 95% of the cumulative rainfall that are verified within the space of the week without losses during the extreme events and with a minimum evaporation loss. In the last 10 years analysed, for a total of 122 extreme events, in 104 extreme events the Bulk samplers have collected rainfall more than automated tipping-bucket. In 14 extreme events an undervaluation more than 10% was evaluated.

The objective of this initial phase of the intercomparison was to single out the counting errors associated with tipping-bucket rain gauge, during extreme events, so as to help the understanding of the measured differences between instruments in the field during the second phase. We want to prove if the automated precipitation gauge, is or not, a reliable and precise device of automated measurements of liquid precipitation with particular interest regarding heavy and extreme events.

Comparison of genetic programming and artificial neural networks in wave height forecasting

Hadi Sanikhani[1], Mohammad Mehdi Moayeri[1], Özgur Kisi[2] and Davood Farsadizadeh[1]

[1]Water Engineering Department, Faculty of Agriculture, University of Tabriz, Iran, e-mail: hadi.sanikhani@yahoo.com, mm100@ymail.com, farsadi@tabrizu.ac.ir
[2]Civil Engineering Department, Canik Basari University, Samsun, Turkey, e-mail: kisi@erciyes.edu.tr

Prediction of sea surface waves is an important issue for some of the most relevant human activities in the coastal zone. In the last decades, emerging approaches over the conventional techniques are based using Genetic Programming (GP) and Artificial Neural Networks (AANs). In the present study, the GP and ANNs were used to forecast wave height variations for the 1h, 12h, 24h, 3 daytime intervals. The measurements from a gauge at Gilan province in north of Iran were used to train and validate the ANNs and GP models for the period of September 1998 to September 2002. Statistical parameters, namely, the root mean square error and correlation coefficient were used to measure the performance of models. It was found that the ANNs and GP models could be successfully employed in forecasting wave heights. Comparison results indicated that the GP was superior to ANNs in forecasting wave heights.

Keywords: Wave height, Genetic programming, Artificial neural networks, Forecast

Assessing the origin of the acidity in a humic boreal river draining peatlands and sulfide-bearing soil materials

J. Saukkoriipi[1], K. Martinmäki[1], H. Marttila[2], K. Heikkinen[1], S. Tammela[2], J. Tertsunen[3], M. Tolkkinen[1], R. Ihme[1] and B. Klöve[2]

[1]Finnish Environment Institute (SYKE), BO Box 413, 90014 Oulu, Finland
[2]University of Oulu, BO Box 4300, 90014 Oulu, Finland
[3]Centre for Economic Development, Transport and the Environment of North Ostrobothnia, BO Box 86, 90101 Oulu, Finland

The River Sanginjoki watershed in northern Finland is one of the most notable recreational sites in Oulu region. It is one of the tributaries of the River Oulujoki and has the total catchment area of 400 km2, of which the proportion of lakes is 2.7 %. The catchment is mainly covered by forests and peatlands, which are drained intensively for land use e.g. forestry purposes. Furthermore, around 79 % of peatland forests and 38 % forests on mineral lands are ditched (Mykrä et al., 2012). Besides high coverage of peatlands, sulfide-bearing soils and black schist regions can also be found within the catchment area.

Due to the catchment geology and land use the River Sanginjoki has experienced temporary periods of increased acidity, especially during autumn runoff (Laajala et al., 2006). Pulses of low pH are harmful to stream biota and have been found to decimate e.g. fish populations. The pH value has dropped frequently under 5,5 in the lower parts of the river main channel and even lower (< 5) in the tributaries.

Due to the multifaceted geology of the catchment, the assessment of the origin of the acidity in the River Sanginjoki is challenging. Herein the origin of the acidity was investigated via water sampling scheme that covered ten sampling sites in the watershed. The sampling frequency was 12 sets of samples in 2010 and 2 sets in 2011. The total amount of samples taken was 139.

The organic anion concentration exceeded the non-marine sulfate concentration in all main channel sampling sites in the river and in 18 times out of 20 samples in the tributaries. Furthermore the low pH values were associated with high DOC concentrations in the drainage basin, whereas no correlation between sulfate and pH were found in the main channel or in the tributaries. The longer-range chemical oxygen demand (CODMn) concentrations were also associated to lower pH values, whereas no correlation between sulfate and pH was found.

The sulfate concentration varied from 1.2 to 5 mg dm-3 in the main channel and from 2.1 to 18 mg dm-3 in the tributaries. Furthermore the dissolved organic carbon concentrations varied from 14 to 44 mg dm-3 in the main channel and from 18 to 54 mg dm-3 in the tributaries, respectively. In conclusion both the dominance of the organic anion and also the hydro geochemical characteristics of the river drainage basin indicate that the temporary low pH values in the River Sanginjoki are mainly caused by leaching of organic acids from the peatland dominated areas.

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Flood risk modelling for basin of the Daugava River

Juris Seņņikovs, Aigars Valainis and Anita Piliksere

Laboratory for Mathematical Modelling of Environmental and Technological Processes, Faculty of Physics and Mathematics, University of Latvia, LV 1002, Zellu str 8, Riga, Latvia, e-mail: anita.piliksere@gmail.com

The Daugava River is the largest river in territory of Latvia. Catchment area of the River Daugava in territory of Latvia is approx. ~24 000 km^2 which is one third of basin total area. There are three major and several smaller hydropower plants and several big lakes located in the basin of Daugava. (1) Snow and ice melting during spring time for urban territories situated on the banks of rivers and (2) storm surges in the winter for territories near the Daugava River mouth in Gulf of Riga are considered as the most significant flooding factors.

The aims of the study were (1) the development of the flooding scenarios caused by spring snow-melt flood of different return periods, (2) the building and calibration of the hydrodynamical mathematical model taking into account hydrotechnical structures for the domain potentially vulnerable for flooding, (3) the calculation of flood events with different return periods, (4) mapping the potentially flooded areas and (5) building on Internet based flooding information system.

The time series of runoff for 27 monitoring stations for the basin of the River Daugava were analyzed for more than 54 year long time period. Run off occurrence probability was calculated. According to the occurrence probability three scenarios with return period once in 10, 100 and 200 years were constructed. Hydrographs from the data in 27 monitoring stations for the observed flood event bringing probability close to 1 % were created for model calibration. In total 819 statistically scaled hydrographs were used for all basin as the boundary inflow conditions.

Digital terrain model based on triangular mesh of the topography for potentially vulnerable territories was created using digitalized 1:10 000 maps. Additionally, linear objects (watercourses, dams, etc.) of hydraulic importance were included in the terrain. Totally 40 tributaries of the River Daugava having total length ~2500 km were included in the domain. Cross-sections with spatial step approx. ~1.5 km along the river network were created.

Hydrodynamical 1D model was built employing the hydraulic modelling system MIKE 11. (1) Weir parameters for small hydropower plants (width and crest level), (2) stage discharge relation for large power plants and (3) scenarios of hydrological regime for the highly regulated Lake Lubana were included in the model.

Model system was calibrated for the real flood event of year 1956 (close to the scenario once in 100 years) based on the water level observation in 27 monitoring stations. Water level in small hydropower plants was calibrated to designed value of the water level for return period once in 100 years. Various friction coefficients for each river or its part were modified during calibration.

The method for the mapping of the results of 1D hydrodynamical calculation on the triangular mesh was proposed and applied. The typical spatial resolution of approx. 60 m was used with a total number of triangles around 75 000 000.

Evalvation of two phase numerical modeling of head loss over stepped spillway

M.R.Shojaeian[1] and R.Mohammadpour[2]

[1]Department of Civil Engineering , Islamic Azad University, Estahban Branch,
e-mail: Mrshoja_2010@yahoo.com
[2]Graduate PhD student in River Engineering and Urban Drainage Research Centre (REDAC),
Universiti Sains Malaysia, Engineering Campus, 14300 Nibong Tebal Pulau Pinang, Malaysia,
e-mail: reza564@gmail.com

Construction of diversion dams is a method for water diversion from rivers. In this way, using step spillways are more common because of easy construction and high energy losses. On the other hand there are not a clear equation for optimum dimensions and energy losses calculation. In this study flow patterns over a step-spillway with free-surface flow was simulated using Fluent software. The model solved Reynolds-averaged Navier-Stokes equation to predict dissipation of energy on the step spillway. For complex free-surface flow treatment, the VOF (volume of fluid) method with geometric reconstruction scheme was applied and turbulence was simulated using K- ε standard equations. In mesh generate, a structured and an unstructured meshes were used and the highest density of the mesh spacing was selected near the steps, walls and also free surface to obtain more accurate results. Comparing amount of energy dissipation in the end of spillway has a good agreement with experimental data obtained by other researchers. The spillway model has the standard WES profile continue with steps untill the toe.

Keywords: Spillway Simulation; Numerical model; Fluent; K- ε ; Energy dissipation; VOF

Surface water – groundwater interaction: Hyporheic processes of a regulated river

Dmytro Siergieiev, Anders Widerlund, Angela Lundberg

Luleå University of Technology, 971 87 Luleå, Sweden, e-mail: dmysie@ltu.se

During the last two decades large attention has been paid to the interface between rivers and groundwaters. Previous studies mainly focused on pristine streams with minimal human impact on the flow pattern (e.g (Triska et al., 1989). Nowadays, attention is drawn towards large regulated river systems that comprise 58% of the large world's rivers (Nilsson et al., 2005). Therefore, research on hyporheic processes in such rivers is vital. Studies performed in large regulated rivers show an impact on hyporheic variables such as pressure, temperature, water chemistry and spatial extent of the hyporheic zone. The goal of this study is to extend the knowledge regarding geochemical processes in the hyporheic water by performing comprehensive analyses of hyporheic zone water chemistry of a large regulated boreal river.

The hyporheic zone processes together with the river water were studied during a one year period in the regulated Lule River, Northern Sweden. Major features and variations were compared to the pristine settings of the neighboring Kalix River. A monitoring program included continuous measurements of water levels, electrical conductivity and water temperature, with occasional sampling of water chemistry that comprised filtered (<0.45 µm) concentrations of Ca, Na, Mg, K, Si, Fe, Mn, Al and organic carbon.

The key difference in hydrological regime between regulated and pristine conditions was the absence of a spring peak, and overall reduced water discharge variations throughout the year in the regulated river. As a result, a fine-grained clogging layer forms on the regulated river bed, which restricts surface water-groundwater exchange. Presence of the clogging layer causes a longer residence time of the groundwater resulting in with higher filtered concentrations in the hyporheic zone.

As a result of the short time regulation, frequent oxygenation of the subsurface by infiltration of the surface waters induced lower pH, higher DOC content, and increased filtered Fe, Mn, Si, K, Na, and Al concentrations. Enrichment of the hyporheic water in K and DOC occurs during water level fluctuations, when these elements are leached from the upper soil layer rich in decomposing organic matter.

Changes in river stages due to river regulation also reach groundwater up to 50 m away from the river, thus initiating water table variations in the aquifer. It is hypothesized that in the studied area these water level variations induced a decrease in groundwater pH (up to one pH unit lower than the reference groundwater a few hundred meters uphill). Finally, possible acidification of soils and groundwater adjacent to the Lule River groundwater may in turn affect the riparian and riverine ecosystems negatively.

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Pesticide losses in a small Finnish agricultural catchment

Katri Siimes[1,2], Harri Koivusalo[1], Anri Aallonen[3], Pirkko Laitinen and Eija Karhu

[1]Water Engineering, Aalto University School of Engineering, Department of Civil and Environmental Eng., P.O. Box 15300, FIN-00076 AALTO, Finland, e-mail: katri.siimes@aalto.fi
[2]Finnish Environment Institute, P.O.Box 140, FIN-00251 Helsinki, Finland
[3]Ramboll Analytics, Niemenkatu 73, 15140 Lahti, Finland

Agricultural pesticides are used to protect crop from weeds, pests and plant diseases. However, pesticides may cause harmful or toxic effects to non-target biota (including humans). Therefore, pesticides coming to market and their use are regulated by EU and national legislation. Despite of this legislation, pesticides are repeatedly found in surface waters and in groundwater all around Europe causing water quality problems. The environmental quality standard directive (2008/105/EY) requires member states to produce an inventory of emissions, discharges and losses for priority substances. In Finland, the first inventory is to be made on river basin districts and it should also include 15 nationally selected priority substances, of which six are pesticides commonly in use in Finland. Currently there are not enough data to base the pesticide loss inventories on measurements. Most Finnish rivers have no pesticide concentration data at all. Since 2007, pesticides have been monitored annually in 7–10 Finnish rivers. After the first year, the sampling has been focused on the growing season, when pesticide concentrations are high but water volumes low. This monitoring has been designed to reveal potentially harmful elevated concentrations, and it is not optimal for estimating pesticide loads to surface waters.

The objective of this study was to produce background information for the Finnish pesticide loss inventory. A case study of pesticide export focuses on Löytäneenoja research catchment (5.6 km^2 with 85% agricultural land use). It utilises the data collected in previous research projects: interviews of local farmers in MYTVAS (e.g. Mattila et al. 2007), pesticide residue analyses in surface water samples in VESKA2 (Siimes et al. 2012) and discharge measurements. In 2004, the main crops cultivated in the fields were spring cereals and sugar beet and, hence, almost 90% of fields were sprayed with pesticides containing altogether 35 different active ingredients. Of the used compounds 22 were analysed and 11 was detected from water samples taken at the measuring weir at the catchment outlet. The loads were calculated for the most widely used compounds: phenoxy acid herbicides, sugar beet herbicides and low-dose herbicides. The loads were given as mass passing the measurement weir, as mass per cropping area (cereals or beets), and as percentage of the applied substance. The uncertainty and error related to the sampling frequency, the handling of concentrations below detection limit, and the missing information from the ¼ of the fields were evaluated. The calculated high uncertainty was caused mainly by non-sampled high water volumes and concentrations below detection limit. Only minor parts of the calculated annual losses were produced during the intensive sampling period in May-October: e.g. for the most often detected compounds, ethofumesate and MCPA, the proportions of losses during this time were 10% and 5%, respectively.

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Numerical and field investigations of unsteady river flow downstream hydropower plant (HPP)

Arvydas Šikšnys[1], Narimantas Titas Ždankus[2] and Gintautas Sabas[3]

[1]Aleksandras Stulginskis University, Studentu str. 11, LT-53361 Akademija, Kauno r., Lithuania, e-mail: arvydas.siksnys@gmail.com
[2]Kaunas University of Technology, K. Donelaicio str. 73, LT-44029 Kaunas, Lithuania, e-mail: narimantas.zdankus@ktu.lt
[3]Vilnius Gediminas Technical Univerity, Sauletekio av. 11, LT–10223 Vilnius, Lithuania, e-mail: sabas@ap.vgtu.lt

Sudden and often fluctuations of water discharges and levels in the downstream reach of the hydropower plant make water fauna and flora existence conditions unbearable. Besides, river bed here is subjected to long lasting and intensive scour and deformations. The aim of our investigations is to develop measures improving the water flow regime in the downstream reach of the HPP.

The Nemunas River and Kaunas HPP were selected as basis for our numerical and field investigations. To initiate positive changes of river flow regime, current regime was investigated first of all. Actual flow regime below the HPP was observed and analysed on the ground of long lasting dynamic measurement data. Numerical treatment of field measurement data and flow simulation works were arranged and carried out simultaneously. Numerical hydrodynamic model MIKE-21 enabled us to evaluate existing river flow conditions and to apply the model for simulation of many different turbine regimes and to select the optimal one. The content of our research was as follows: 1) analysis of typical turbines regimes while switching them on and off and flow regimes downstream; 2) continuous long lasting measurement of water level in many cross-sections of the river under investigation downstream the HPP; 3) numerical simulation and investigation of untypical turbines regimes while switching them on and off and flow regimes downstream with application software MIKE-21 in the same unsteady flow conditions in which field measurements were made. Calibration of numerical model was performed and slight corrections were introduced into the model.

Obtained data on water level and flow rate dynamics downstream the Kaunas HPP have been analysed and optimal turbine operation regimes were determined. Numerical two dimension model MIKE-21 was prepared and calibrated for the same unsteady flow conditions. Analysis of possible errors was performed and reliability of the results was verified. Developed measures for river flow regime improvement downstream HPP seem promising and giving valuable positive changes for water fauna and flora conditions.

Flood risk reduction benefit of water retention basins in changing climate

J. Silander

Finnish Environment Institute (SYKE), P.O. Box 140, FIN-00251, Finland, e-mail: jari.silander@ymparisto.fi

The Floods Directive obligates member states to develop higher quality risk and hazard maps. The maps and data derived can be used to calculate economic damage more accurately. Also, in the preliminary flood risk assessment, the effectiveness of existing man-made flood defence quantity should be evaluated. Thus, there is an urgent need to evaluate the "optimal" type and quantity of flood protection in changing climate. This requires that climate proofing measures will be compared. We may have to increase quantity of flood protection or build new water retention basins. This is to guarantee the efficient flood protection. This paper explores how to calculate flood risk reduction benefit of water retention basins in changing climate.

Runoff simulations for different water retention scenarios have been carried out in several projects by using runoff simulation models. Even, we know that the design of water retention basins using runoff models is very expensive. Thus, we got an idea to calculate benefits of water retention (euros per cubimeter) prior to design or implementation of these areas. This we do by using cost-benefit analysis with in conjunction with simpler runoff models.

We calculated the optimal quantity of flood protection in current and future climate with predicted flood frequency distribution parameter changes. We show, how other economic values are changing in time and how flood policy influences on dead weight loss and flood risk. We included uncertainty analysis in our calculations. We validated the model in our largest flood risk area, the city of Pori. The city of Pori is located in the Kokemäenjoki catchment (27 000 km²). The flood risk area is protected by a dyke, population is 80 000 people. Expected flood damage for a HQ 1/250 event is over 300 million Euros (direct flood damage). Some results imply that water retention benefits would increase 20 % by 2070-2099, as discharges are predicted to increase.

New heavy rainfall distributions and climate change modelling in urban areas

Jari Silander[1], Juha Aaltonen[1] and Jarmo Koistinen[2]

[1]Finnish Environment Institute (SYKE), P.O. Box 140, FIN-00251, Finland, e-mail: jari.silander@ymparisto.fi, juha.aaltonen@ymparisto.fi
[2]Finnish Meteorological Institute (FMI), P.O. BOX 503, FIN-00101, Finland, e-mail: jarmo.koistinen@fmi.fi

Prior to this project, there was not much up-to-date research-based information on the intensities and probabilities of short-duration intensive heavy rains. For dimensioning purposes, community planners have used rainfall intensity distributions from the 1960s, based on relatively few rain gauge measurements.

The RATU project (rankkasateet ja taajamatulvat = heavy rains and floods in urban areas) was carried out to

- estimate the present probabilities of the occurrence of heavy rains, using weather radar and rain gauge observations
- estimate the climatologically representative heavy rains of selected summers and the expected changes in the occurrence of heavy rains
- assess the suitability of existing urban hydrology models for Finnish conditions
- assess the consequences of this new information for storm water management by modelling two experimental basins

The data used in this research project comprised of all weather radar records from the years 2000-2005. The data covered the entire territory of Finland. Despite the short observation period, the material is huge, several milliards of records. Thus it is possible to give recurrence time estimates even for rare precipitation events, e.g. for a rainfall that occurs on the average only once in 3000 years. An new methodology to study climate change impacts on urban storm water system using numerical models was tested. The model study was carried out in the city of Espoo using commercial MIKE SHE and MOUSE –software. Study indicated that risk of flooding is increasing. There was no immediate need to improve storm water system, but obviously culverts and ditches in downstream need to be revised.

Experiencing community-based environmental monitoring using modern data collection systems

Jari Silander[1] , Timo Toivanen[2] and Matti Lindholm[1]

[1] Finnish Environment Institute (SYKE), P.O. Box 140, Helsinki, Finland, e-mail: jari.silander@ymparisto.fi, matti.lindholm@ymparisto.fi
[2]VTT Technical Research Centre, P.O Box 1000 – VM3, 02044 VTT, Finland, e-mail: timo.toivanen@vtt.fi

Europe is facing increasing monitoring requirements to meet obligations under, for example, the Water Framework Directive and the UN Convention on Biological Diversity (CBD). Europe's open data policy and initiative for a Shared Environmental Information System, with interface standardization gives entrepreneurs an opportunity to, in collaboration with existing data providers, develop new innovations for community-based environmental monitoring. These innovations should not only provide an effective way of gathering data but, to support the EUs innovation policy, should also engage the community in the sustainable management of its environment. This paper explores experiences in collecting citizen algae observations in Finland using mobile technology and shows how to benefit from open data interfaces. Paper also explores international methods and lessons learned, but also show how to access open data source.

A key element of any participatory sensing is knowledge exchange with large crowds. An example of common conceptual architecture of participatory sensing is presented in figure 1. Observations from the users are sent to a central server where they are stored to a database. Observations can be retrieved using web data interfaces for analysis and research. In addition, the gathered data can be visualized on a map.

In an ongoing project, a participatory sensing tool was used for collecting algae observation from citizens. Citizens could report their algae observations by using their mobile phones and through a lake information wiki service [http://www.jarviwiki.fi]. Citizens evaluated the level of algae appearance in four-level scale (none/some/plenty/extreme amount of algae). In addition, they could take a picture of algae using the camera of the mobile phone and attach the picture to the observation. In the summer 2011, we received 374 algae observations in total. In our future work, we are planning to provide water related information back to the users.

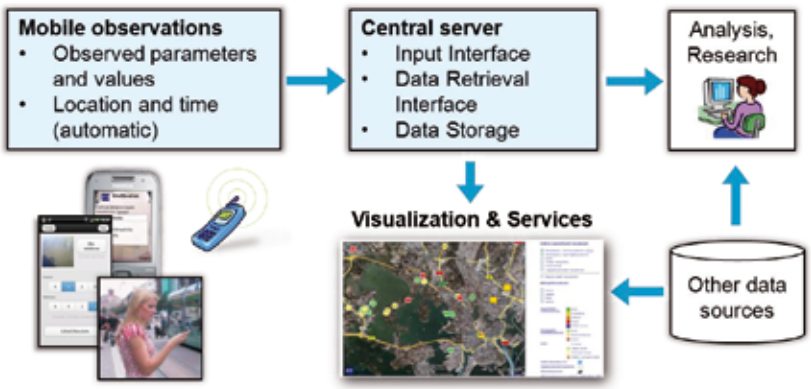

Figure 1. A common conceptual architecture of participatory sensing.

Real-time water level data transmission, storage and handling in Finland

Hannu Sirviö[1] and Heidi Sjöblom[2]

[1]Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland, e-mail: hannu.sirvio@ymparisto.fi
[2]Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland, e-mail: heidi.sjoblom@ymparisto.fi

Finnish Environment Institute (SYKE) and the Centres for Economic Development, Transport and Environment are measuring water level in cooperation in about 800 stations. In about 360 stations has been automated with real-time data transmission to databases in SYKE. Automatic devices have sampling interval between 15 minutes and 2 hours and daily about 15 000 water level values are collected from devices. Need from temporal water level values more frequent than daily values is growing putting further pressure for automation.

Data is collected to SYKE through 4 data transmission methods: GSM, GPRS (TCP), SMS and fixed telephone network. Because devices are manufactured by different companies which have their own protocols for data transmissions there is for every data transmission class different program interface. The programming interface is easily modifiable and extendable for new device type or manufactures and new data transmissions. Incoming data is filtered through the interface to unique data format suitable for database transfer. Data is storaged to two databases in SYKE. Temporal data is stored to Hydrotempo-database and calculated daily values to Hydro-database. Daily average values are controlled and manually checked values which are intended for all users. All data is internally available through HYD-valikko program and for all users through Hertta-service. The data is open for use and free of charge.

For reliable perfomance the system is monitored continuously by automatic alarm system. To persons who are responsible for monitoring a message is sent in the case of failure. If data has not collected for 24 hours or there are caps in the data a message is sent by email or SMS to responsible persons. If device is working but there is a failure of reading and storing the data or the data receiving devices are out of order software developers are notified by these events.

Quality control is at the moment mainly manual but severe errors in the data are flagged and are not used in the daily average calculations. There is a continuous development in progress for automation the quality control stages and further lower manual labor by use of statistical methods and feedback form watershed modeling system. There are also alerts for rapidly raising water level events for field workers.

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Twenty years of water quality monitoring in Norwegian rivers – trends, patterns and lessons learnt

Eva Skarbøvik[1] , Per Stålnacke[1] , Øyvind Kaste[2] and Kari Austnes[2]

[1]Bioforsk Norwegian Institute for Agricultural and Environmental Research, FA Dahls vei 20, NO-1432 Ås, Norway, e-mail: eva.skarbovik@bioforsk.no; per.staalnacke@bioforsk.no;
[2]NIVA, Gaustadalléen 21
NO-0349 Oslo, Norway, e-mail: oka@niva.no; kau@niva.no

Results of the monitoring of riverine loads to Norwegian coastal waters from 1990 to 2010 are presented. The monitoring is carried out under the RID programme (Riverine Inputs and Direct discharges) which is part of a joint monitoring programme under the "OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic". The following parameters have been monitored: Six fractions of nutrients (total phosphorus, orthophosphate, total nitrogen, ammonium, nitrate and silicate); eight heavy metals (copper, zinc, cadmium, lead, chromium, nickel, mercury and arsenic); one pesticide (lindane); seven PCB compounds (CB28, CB52, CB101, CB118, CB138, CB153, CB180); and four general parameters (suspended particulate matter, pH, conductivity and total organic carbon).

The RID Programme is to date Norway's largest national riverine monitoring programme, with a database that has lately undergone a thorough quality assurance (Stålnacke et al. 2009; Skarbøvik et al. 2011). Altogether 46 rivers are monitored today, of which nine rivers, from River Glomma in the south to River Alta in the north, have been scrutinised in more detail in this paper. Long-term trend analyses of loads have been performed for these rivers for the period 1990-2010. The resulting trends show, amongst others, that both nutrient and metal loads have been reduced in many rivers, and only one river shows increased loads of total nitrogen. The reason for these trends will be discussed including a presentation of anomalies and time-dynamic patterns. In addition, the trends in metal and nutrient loads will at the oral presentation be discussed based on an assessment of such aspects as:

- sampling frequency;
- changes in detection limits over time;
- hydrometeorological variability; and
- the nature of the specific compounds (dissolved or associated with particles).

Finally, the design of the monitoring programme will be discussed, related to number of rivers monitored and the frequency of sampling.

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Implementation of the water framework directive 2000/60/EC (WFD) in Lithuania: How does it work?

Loreta Steponėnaitė
Mykolas Romeris University, Ateities st. 20, LT-08303 Vilnius, Lithuania, e-mail: losteponen@stud.mruni.eu

In the beginning of the 21st century, the Republic of Lithuania experienced many new and essential changes. The water sector of the environmental policy was also no exception. Activity transformations in this sector were mainly influenced by the state's integration into the space of the European Union countries. Validated strategies, directives, requirements, and norms determined by other legal documents are aimed to achieve as more effective management of water resources as possible.

The research analyses the implementation of WFD in Lithuania. It also reveals the significance of the water sector nowadays and problems of this field in Lithuania. The purpose of the research is to explore the water resources policy in Lithuania by answering the following questions: What is the significance of the WFD to the water resources management in Lithuania? What ways and measures of implementation of the WFD are important to water bodies that have to be managed and protected according to the natural hydrological boundaries of river basins instead of the administrative? Is the tangible impact visible? Shall the objective to conform to allowable rates and achieve good water quality be associated mostly with the practical future vision of the EU, while water resources management in Lithuania invokes a new principle of the water body management?

The research is focused on analysis of available information and literature sources. The following methods are used to develop the research: individual interviews and consultations. Special attention is paid to the management of water resources in line with the principle of sustainable development, especially in the field of protection of water bodies, the use of water resources, and their management.

Extreme weather in small catchments, a new method for flood protection: ExFlood

Jannes Stolte[1], Ola Hanserud[1], Helen French[2], Bent Braskerud[3], Jarle Bjerkholt[2]

[1]Bioforsk Soil and Environment, Frederik A Dahlsv. 20, 1432, Ås, Norway, e-mail: Jannes.Stolte@bioforsk.no, ola.hanserud@bioforsk.no
[2] The Norwegian University of Life Sciences (UMB), P.O. Box 5003, 1432 Ås, Norway, e-mail: helen.french@umb.no, jarle.bjerkholt@umb.no
[3]Norwegian Water Resources and Energy Directorate, NVE, Oslo, Norway, e-mail: bcb@nve.no

Extreme weather events are often very local and require the description of processes at a very high time resolution. Damages for several million Norwegian kroner each year caused by extreme storm events have been reported (FNH, 2009). Based on the vulnerability of infrastructures to extreme weather events today, it is anticipated that the damages to infrastructure will increase due to climate change and higher frequency of extreme events. The major objective of the ExFlood project is to define and analyze measures to combat negative impact of extreme weather events on infrastructure in small watershed areas in Norway and to incorporate this in a land use planning tool.

Existing models for different land uses e.g. MOUSE (urban), LISEM, COUP (agricultural, natural), MIKE-SHE (different land uses) will be combined to analyse effects of measures in different parts of small catchments. The hypotheses is that the use of area specific measures upstream in a catchment can cause large reductions in peak flow by delaying the peak and increasing the storage capacity of elements in the landscape, e.g. retention ponds, rain gardens, barriers in water streams etc. The complexity of this chain-of-models tool depends on the choice of basic models included. Simplification of the model will be achieved through the use of sensitivity analysis of each model component and land use.

Three Norwegian study areas (Fredrikstad, Trondheim and Sandnes), were selected to test the modelling approaches. The selection was based on (i) data accessibility, (ii) existing research, (iii) reported problems with flooding and damages to infrastructure, or a combination of these items. An initial step of the project was to carry out an interview survey in the participating communities. As could be expected people living close to creeks prone to flooding were most conscious about the effects of extreme weather events. Some of these or their neighbours have taken measures against flooding, while others trust that measures taken or to be taken by the municipal administration will suffice. Of those not affected, house owners were more positive to install measures to infiltrate or retain rainwater when compensated than farmers, of which most were reluctant or negative to give up productive land even if compensated. Further analysis of these data is ongoing as well as modelling with different models (described above). A database of possible measures is being fine-tuned by consulting the project reference group to discuss the feasibility of each suggested measure, we also plan to quantify the effect of some of these measures. The goal is to create a land use planning tool for end-users to run locally (or a web-based system, depending on the complexity). At the moment we are exploring technical possibilities of combining a GIS application with the measures database to design a land use strategy to reduce the peak flow.

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Impact of climate change on water availability and hydropower production in the Swiss Alps

Manfred Stähli[1], Mélanie Raymond-Pralong[1], Massimiliano Zappa[1], Frank Paul[2], Thomas Bosshard[3] and Christian Dupraz[4]

[1]WSL Swiss Federal Research Institute for Forest, Snow and Landscape, Zürcherstrasse 111, CH-8903 BIRMENSDORF, Switzerland, e-mail: manfred.staehli@wsl.ch
[2]University of Zurich, Department of Geography, Winterthurerstr. 190, CH-8057 Zurich,Switzerland, e-mail: fpaul@geo.uzh.ch
[3]ETH Zurich, Institute for Atmospheric and Climate Science, Universitätstrasse 16, CH-8092 Zurich, Switzerland, e-mail: thomas.bosshard@env.ethz.ch
[4]BKW FMB Energie AG, Viktoriaplatz 2, CH 3000 Bern 25, Switzerland, e-mail: christian.dupraz@bkw-fmb.ch

In Switzerland, 56% of the current total energy production is originating from hydropower. With the planned phasing out of nuclear energy, the importance of hydropower production will increase even more. Knowing that the potential for new hydropower plants is very limited, the urgent question remains to what extend future hydropower production will be affected by climate change.

To broadly illuminate this question, a comprehensive research study was issued by *swisselectric research* and the Federal Office for Energy. For selected hydropower reservoirs in different regions of the country the change in glacier extent, snow storage, runoff and hydropower production were calculated for an early (2021-50) and a remote (2070-99) time period. To this end, climate change scenarios of the European research project ENSEMBLES were statistically post-processed using a seasonally variable delta-change approach. Glacier retreat scenarios for the 21th century were elaborated by means of hypsographic modelling. Snow cover, evapotranspiration, soil water storage and runoff were calculated at a daily time step using a state-of-the-art hydrological model (PREVAH) that was verified with 30-year runoff and snow data of the corresponding catchments. Finally, a power-plant operation software was fed with the simulated water inflow to the reservoirs and water intakes to calculate production and turnover under the future runoff regimes (with the assumption of a present-day electricity market).

In this presentation we will focus on two case studies (Stähli et al., 2011): one in central Switzerland (Kraftwerk Oberhasli) and one in southern Switzerland (Kraftwerk Mattmark), both with a significant areal fraction (20-30%) that is glacierized today. Our calculations reveal a substantial reduction in glacier-covered area and changes in snow storage and melt throughout the 21th century in both regions. As a result, the main inflow to the reservoirs will occur earlier in spring, and pre-winter inflow will increase. Total annual runoff will decrease, but regarding the magnitude there is a considerable range of uncertainty originating from the different climate change scenarios.

The conclusion of this study is that different regions in Switzerland will be affected differently by climate change. Overall, we expect only a minor reduction in hydropower production for the 21th century, considerably less than what was calculated in earlier studies.

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Occurrence and water properties of groundwater outflows from porous deposits on Polish Plain, western Poland

Anna Szczucińska

Department of Hydrometry, University of Adam Mickiewicz, ul. Dzięgielowa 27, 61-680, Poznań, Poland, e-mail: szana@amu.edu.pl

Major part of Polish Plain (central Europe) was shaped during last glaciation and was covered with thick glacial and glacifluvial deposits. So far, this area was considered to be poor in groundwater outflows (springs, seeps). The undertaken study aimed to map existing groundwater outflows and to analyse their water properties on Lubuska Upland, in western part of Polish Plain. The area of this region is about 5,200 km2. The hydrographic mapping of groundwater outflows included: site and groundwater outflow description, measurements of the spring water temperature, specific electrical conductivity (SpC) and pH. Moreover, in 21 representative groundwater outflows water was analysed for major anions, major cations and selected trace metals. All together over 600 groundwater outflows were recorded of which 42% are springs (next to seeps). Their water discharge ranged from 0.001 to 45 dm3 s-1. Most of them were located on or under slopes of river valleys. The average temperature of the water was close to 10°C. The most common was hydrocarbonate-calcium water type. The pH ranged from 6.5 to 8.9 and SpC from 224 to 786 µS cm-1. The waters often exceeded the groundwater quality limits for trace elements: iron (maximum 14 mg L-1) and manganese (1.5 mg L-1).The study revealed that the groundwater outflows are much more common than previously thought in the areas covered during the last glaciations on Polish Plain. The outflows water properties depend mainly on aquifer sediment type, local water flow paths, near ground surface geochemical reactions and anthropogenic influence.

Corss structures and their effects on river morphology, case study Kor River Iran

Mehrdad Tayebipour[1], Ali Torabi Haghighi[2] and Reza Mohammadpour[3]

[1]Fars Regional Water Authority, P.O. Box 351, Shiraz, Iran, e-mail: m_tp@ymail.com
[2]Water resources and environmental Engineering Lab., University of Oulu, P.O. Box 4300, FIN-90014 Oulun yliopisto, Finland, e-mail: ali.torabihaghighi@oulu.fi
[3]University Sains Malaysia (USM), Engineering Campus, 14300 Nibong Tebal, Pulau Pinang, Malaysia, e-mail: rmgips10_red005@student.usm.my

River morphology contains a complex system, and it can be affected by a lot of known and unknown parameters such as climate, basin geology, river slope, discharge, sediment and erosion and human activity. In addition, river morphology plays an important role on the surrounding habitats and its economy. In general, in order to exploit river resources in river system for the benefit of the environment two groups of structures can be constructed in river system which are longitudinal and cross structures. Dams, Barrages and bridges are classified as cross structures in rivers. On the grounds of the place of structure and type of river, rivers give different response to these alterations. In this paper, the side effects of these types of structures on Kor river morphology were evaluated and discussed. Kor river is an alluvial river in southern part of Iran and it supplies water for different purposes in and out of its watershed. There are many structures constructed on the river for the purpose of water supply and or for easy access to the other side of the river. Main structures constructed on the river are two large dams named as (Doroudzan, 1972) and (Mollasadra, 2006) dams and more than 7 diversion dams and some bridges. As a result of these structures existence, the river length is divided into 4 parts and these are upstream of Doroudzan dam which also contains Mollasadra dam as its first part, from Doroudzan dam to polkhan Bridge (constructed 1633) as its second part, from Polkhan bridge to Amir Diversion dam (constructed around 955) as the third part and from Amir diversion dam to Bakhtegan lake as the last part. The last part contains 6 ancient diversion dams. Kor river morphology's 3 last parts are evaluated by comparing the aerial photo in 1965 and new satellite images. The results show the ancient diversion dams which are situated in the fourth part have main role in stability of bed river when compared with other parts.

Sustainability of land-use on peatlands

Anne Tolvanen[1, 2]

[1]Finnish Forest Research Institute, Oulu Unit, P.O. Box 413, FIN-90014 OULUN YLIOPISTO, Finland, email: anne.tolvanen@metla.fi
[2]Thule Institute, University of Oulu, P.O. Box 7300, FIN-90014 OULUN YLIOPISTO, Finland

Finland has a total of about 10 million hectares of mires and peatlands, which is about a third of the country's total land area. About half of the mire area has been drained for the forestry use, and about 60,000 hectares are used annually for peat production. Thirteen percent of the mires are protected. Peatland forestry and especially peat mining cause runoff of nutrients and solid matter to nearby water systems, which has raised strong objection among people towards heavy land-use, especially peat production.

Due to the multiple needs and values relating to the use of peatlands, a Government Programme for the sustainable use Mires and Peatlands is being prepared during 2012, coordinated by the Ministry of Agriculture and Forestry. Practical questions of the Government Programme are: 1) what to do with drained unproductive peatlands, 2) where to direct peat mining, and 3) what are further peatland protection needs. Simultaneously with the Government Programme, a local mire and peatland program is proceeding in Northern Ostrobothnia, the peatland-richest region in Finland. A large interdisciplinary research project was launched as a part of the local peatland program. Information on ecological, social, and economical values of peatlands were collected and compiled in the research project during 2011 and 2012.

In northern Ostrobothnia, the percentage of forestry drained peatlands varies from 47% to 89%, highest values being found in the southern parts of the region. Ecological problems arise from degraded biodiversity, lowered water quality, and the delay in the after-use of cut-over peatlands, which means that their nutrient leaching and greenhouse gas emissions are prolonged. Existing ecological data from several sources and different organizations was compiled, and tens of new high biodiversity areas outside protected areas were found in the region. These areas are recommended to be left out from the heaviest land-use forms, and the most valuable ones could be protected. Based on the preliminary analysis of interviews and questionnaires made to local people, people could be divided into three interest groups: environmentalists, neutrals, and supporters of the commercial use of peatlands. Despite opposite opinions on e.g. nature protection and peat mining, all interest groups showed a concern towards hydrological problems caused by peatland use. Due to the high economical importance of peatlands, however, finishing of peat mining completely would have dramatic effects on the employment of rural communities.

Both ecological and social sustainability of the land-use of peatlands would increase by paying more attention to environmental problems coming especially from peat mining. Minimization of the impacts to nearby waters would increase the acceptance of people towards commercial peatland use. Nevertheless, the large group of people opposing all commercial use of peatlands assumes that both the Government Programme and the regional peatland program will face strong arguments regardless what will be suggested on peatland use.

Rainfall intensity analysis in Central Finland

Ali Torabi Haghighi[1], Meseret Menberu[1], Hannu Marttila[1] and Bjørn Kløve[1]

[1]Water resources and environmental engineering laboratory, University of Oulu, P.O. Box 7300, FIN-90014 Oulun yliopisto, Finland, e-mail: mmenberu@paju.oulu.fi

In order to design a flood control structure in urban areas, one of the main important parameter is runoff. Urban areas, which have a considerable number of small catchments in it, would have a higher probability of being effected by the runoff to be generated from the catchments. When there are many small catchments in one area, it is not feasible to measure discharge in each of the catchments. Rainfall-runoff modeling can be one option of generating the discharge from the catchments. For rainfall-runoff modeling in small catchments, it is obliged to use a rainfall data which suits the catchment area. The available rainfall data is mostly daily basis but the required rainfall data needed for modeling these small catchments should be an hourly data. Therefore, it is necessary to find a relationship between the 24 hours rainfall data and a smaller rainfall duration (e.g. 12, 9, 6 hrs. etc.). There are only 9 stations (Jyväskylä, Viitasaari Haapaniemi, Kauhajoki Kuja-Kokko, Seinäjoki Pelmaa, Ähtäri Myllymäki, Vesanto Sonkari, Kokkola Tankar, Ylivieska lentokenttä, Vieremä Kaarakkala) in Central and West of Finland with short duration rainfall data (10 minute duration). The relation between different rainfall duration for each station is analysed. The results obtained showed a good relationship between different durations with regression coefficients that lie between 0,9 to 0,99. Of these the best regression coefficient is seen between durations of 24 hours and 12 hours which have 0,99 as their value. And the lowest regression coefficient (0,90) is found for duration relationships between 10 minutes and 30 minutes.

Results from Filefjell and Anestølen snow research stations

Elise Trondsen[1] and Heidi Bache Stranden[2]

Norwegian Water Resources and Energy Directorate, Middelthunsgate 29, PO box 5091 Majorstua, N-0301 Oslo, e-mail: [1]eltr@nve.no, [2]hrb@nve.no

Filefjell snow research station (980 m asl., 61 degreesN, 8 degreesE) was substantially upgraded in 2009 and now has automatic monitoring of a multitude of snow parameters. From autumn 2010 a total of 99 parameters are logged at Filefjell. At the site NVE also studies small-scale variability of water equivalent and snow melt from manual measurements.

The Filefjell station is equipped with 6 snowpillows filled with two types of antifreeze, 2 different snow scales (25 m2 and 6.25 m2), a snow depth sensor, a gammasensor (only winter of 2010/2011), ground and soil water monitoring, meteorological parameters (WMO standard), all radiation components (longwave in and out, shortwave in and out) and a comprehensive temperature monitoring of the snowpack, ground surface- and air temperature.

Results from the previous two winters show that the size of SWE monitoring installations appears to be significant in respect to precision. The snow scale of 5 x 5 m registered most snow (SWE), and compared with manual control measurements this seems to be the most realistic. The smaller scale (6.25 m2) also gives promising results, but should be compared with the other installations at least one more winter. The small snow pillow (3.14 m2) measures less snow than control points indicate. The four large and identical snow pillows (6.25 m2) differ as much as 30%, partially explained by small scale difference in snow cover.

The gamma sensor measures SWE and is by measurement principle not influenced by crust and ice in the snow pack. The winter of 2010/2011 at Filefjell was characterized by cold temperatures and alpine-like weather and the difference between the gamma sensor and the other installations where less than we would expect in a more unstable, maritime-like, winter climate.

During the autumn 2011 a new snow research station at Anestølen (430 m asl., 61 degrees N, 7 degreesE) was established with a snow depth sensor, a snow scale (5 x 5 m), a snow pillow and two gamma radiation monitors (one with and one without a shade made of lead). The station also measure rain, wind, temperature, humidity and groundwater. Anestølen is located in a far more maritime climate than Filefjell. We expect more snow bridging here than we have seen the two previous winters at Filefjell and hence the differences between the snow measurement installations to be greater.

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Orivesi permeable reactive barrier – Remediation of contaminated groundwater in Nordic conditions

Sirkku Tuominen[1] and Taina Nystén[1]

[1]Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland, e-mail: sirkku.tuominen@ymparisto.fi

The aim of the project was to study the effects of the Nordic geological and climatic conditions on the design and the performance of permeable reactive barrier (PRB) applications. Another aim of the study was to find a suitable cost-effective reactive medium for use in a field-scale PRB by testing several industrial by-product materials.

Based on preliminary hydrogeological studies, the Asemanseutu aquifer at Orivesi was chosen for testing a pilot-scale granular iron PRB for remediation of chlorinated solvents (Kivimäki et al. 2006). The aquifer had been contaminated with trichloroethene (TCE) and tetrachloroethene (PCE), released from a dry cleaner that operated from 1959 until 1989.

Granular iron (Fe^0) PRB is an in-situ method applicable for treating groundwater contaminated with chlorinated solvents. A range of Finnish granular iron materials were tested with batch and column experiments (Eskola et al. 2007). Results from these laboratory experiments were used in dimensioning the PRB to ensure the removal of chlorinated solvents and their degradation products.

The PRB construct was placed across the path of groundwater flow based on site investigations and groundwater modeling. The PRB is a funnel and gate configuration with an additional control well. Finnish granular iron material was used as the reactive medium in the barrier.

The performance of the PRB application and the removal of the contaminants in the aquifer were observed by the monitoring of the groundwater quality. Samples were taken from several observation wells and also via the control well from the observation tubes placed in the iron fill.

The PCE and TCE degrade completely already in the beginning of the residence time in the iron fill and no remarkable bypass of contaminated groundwater from any side of the PRB has occurred.

The effect of temperature on the degradation of contaminants proved to be less than expected. The mean and median values of temperature in the PRB were 8–7 °C. In Finland the average temperature of groundwater is 5–7 °C, so the chemical degradation can be assumed to occur efficiently enough also in Finnish climatic conditions.

The results of the Orivesi study show that it is possible to make a PRB work both hydraulically and remedially in Finnish hydrogeological conditions found in aquifers that are important for municipal water supply.

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Analysis of water balance and subsurface drainage methods in a clayey agricultural field

Mika Turunen[1], Lassi Warsta[1], Harri Koivusalo[1], Jyrki Nurminen[2], Maija Paasonen-Kivekäs[3], Helena Äijö[2], Merja Myllys[4], Laura Alakukku[5] and Markku Puustinen[6]

[1]Aalto University, School of Engineering, P.O. Box 15200, FIN-00076 Aalto, Finland, e-mail: mika.turunen@aalto.fi
[2]Finnish Field Drainage Association, e-mail: helena.aijo@salaojayhdistys.fi
[3]Sven Hallin Research Foundation, e-mail: maija.paasonen@hallin.fi
[4]MTT Agrifood Research Finland, e-mail: merja.myllys@mtt.fi
[5]Helsinki University, e-mail: laura.alakukku@helsinki.fi
[6]Finnish Environment Institute, e-mail: markku.puustinen@ymparisto.fi

Three-dimensional soil and groundwater flow model FLUSH (Warsta 2011) was applied to investigate the effects of different subsurface drainage methods on the water balance of a clayey agricultural field in Jokioinen (Southern Finland). The study (Turunen 2011) was part of the PVO2 project, which focused on identification of optimal water management methods in cultivated fields. The field was divided into four monitored field sections (area of 9.8 ha in total and slope of <1 %) with an unmonitored field section (4.8 ha) between the research sections. The entire field was simulated as one domain, which facilitated better implementation of boundary conditions and quantification of hydrological interaction between the field sections. Calibration-validation period and paired catchment method were applied to decipher the effects of drain spacing, drain depth and envelope materials. Also, the effects of topography and variation of soil properties on water balance were tested with the model.

When subsurface drain spacing was changed from 16 m to 8 m or 6 m the amount of drain discharge increased while the level of the groundwater table decreased as expected. Simulation results with the model for the total field area indicated that the field sections were hydrologically connected and boundary conditions had a clear role in the runoff and water balance simulations, i.e. drainage operations on a field section affected the runoff results also in the adjacent field section. Since the field sections showed interaction, the paired comparison of runoff measurements from individual field sections was not justified. Steep slopes in the vicinity of the field section borders were found to increase groundwater flow across the border and to decrease subsurface drain flow within the field section.

In some simulations the modeling error was higher than the simulated impact of subsurface drainage method on the runoff components. Therefore, no firm conclusions could be made, e.g. about the effects of improved drainage on surface layer runoff. Uncertainty in the simulations was addressed with a sensitivity analysis (e.g. the effects of grid resolution, soil tillage and drain diameter and spacing on runoff). The advantages of using a 3D model were the possibilities to quantify the effect of spatial spacing of drainage lines, hydraulic connectivity of the field sections and the effects of topography on the water balance. Inclusion of preferential flow in the simulations was crucial.

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Dynamics of ditch erosion and sediment transport in drained peatland forests: a case study at Koivupuro catchment, Eastern Finland

Tapio Tuukkanen[1], Leena Stenberg[2], Harri Koivusalo[2], Hannu Marttila[1], Sirpa Piirainen[3], Bjørn Kløve[1] and Leena Finér[3]

[1]University of Oulu, Water Resources and Environmental Engineering Laboratory, P.O. Box 4300, FI-90014 University of Oulu, Finland, e-mail: tapio.tuukkanen@oulu.fi
[2]Aalto University School of Engineering, Department of Civil and Environmental Engineering, P.O. Box 15200, FI-00076 Aalto, Finland
[3]Finnish Forest Research Institute, Joensuu Research Unit, P.O. Box 68, FI-80101 Joensuu, Finland

Maintenance of drainage ditches in peatland forests increases erosion and transport of suspended solids (SS) to watercourses. The maintenance operations, including complementary ditching and cleaning of old ditches, are assessed to cause the most severe water quality problems in forested catchments. However, the processes and mechanisms of erosion and sediment transport are not fully understood in peatland drainage environments. To better understand these processes an experimental study site was established in the summer of 2011 at Koivupuro catchment located in eastern Finland. Koivupuro site has been under active research since the initial ditching of the area in the 1983, providing excellent background data for the study. In this study, the outlets of the catchment and a smaller nested catchment were instrumented for continuous water level and turbidity measurements. Basic hydrological monitoring contains rainfall, groundwater elevations and snow depth and density measurements. Extensive *in situ* measurements of erosion and sediment transport were initiated after the ditch network maintenance in August 2011. The spatial distribution of erosion and sediment transport is measured with erosion pins, ditch bottom and bank sediment collectors, TIMS-collectors, and by measuring the morphological changes in ditch cross-sections with a pin meter and a 3d laser scanner. Furthermore, soil samples are collected for detailed laboratory analyses and erosion strength is measured *in situ* using a cohesive strength meter (CSM).

Data from the field measurements and continuous monitoring are used to study in-ditch erosion processes and sediment transport during the first years after the ditch network maintenance. Special attention is paid to the spatial and seasonal variation of these processes, and influence of ditch bottom and bank erosion on SS load. Furthermore, the results of this study will be applied to erosion and sediment transport modelling at ditch and catchment level. This presentation introduces the applied methodology for the experimental field measurements and some early-stage results and experiences from the Koivupuro study site.

Simulating the hydrological effects of changes in the precipitation regime in the Jordan River region

Tobias Törnros[1] and Lucas Menzel[2]

Institute of Geography, Heidelberg University, Im Neuenheimer Feld 348, 69120 Heidelberg, Germany, e-mail: [1]tobias.toernros@geog.uni-heidelberg.de, [2]lucas.menzel@geog.uni-heidelberg.de

The Leaf Area Index (LAI) is the one sided leaf area. In many evapotranspiration models it is an essential parameter regarding the soil-atmosphere interaction. LAI is often parameterised with an intra-annual but without an year to year variation. This may obstruct the model´s possibility to correctly simulate the effects of a change in the precipitation regime. In this study, LAI was simulated as a function of precipitation. Based on climate projections, the regional water balance was thereafter simulated with a hydrological model. It was investigated how the projected climate change affects the LAI and the simulated water balance components in the Jordan River region.
For the time period 1982-1996, monthly regression analyses were conducted between interpolated precipitation and LAI received from the remote sensor Advanced Very High Resolution Radiometer (AVHRR). Based on the derived relationship, LAI was thereafter simulated and validated for several land-uses and the years 1997-2002. The simulated LAI showed a high correlation with the observed values (r^2 between 0.74 and 0.96). After validation, LAI was simulated for time periods were no LAI measurements exist.

Several climate projections based on the IPCC emission scenario A1B show a general precipitation decrease in the Jordan River region (Smiatek, 2011). The decrease is projected to be unequally distributed over the months. A change within the intra-annual precipitation is believed to have an effect on the vegetation phenology. Based on spatially interpolated climate data (precipitation, temperature, rel. humidity, radiation, wind speed) the water balance components were simulated by applying the physically based hydrological model TRAIN. The model has among others been used when simulating the hydrological effects of land-use change in the same region (Menzel et al., 2009). In this study, TRAIN was applied on a 1x1km spatial scale and two time periods: 1961-1990 and 2031-2060. The water balance components were first simulated by a using a LAI with an intra-annual, but no year to year variation. In the next step, the same time periods will be simulated by using a dynamic LAI based on the derived relationship with precipitation. This is believed to improve the regional simulation of the hydrological effects of climate change. The result will be evaluated according to monthly changes of transpiration, bare soil evaporation, runoff, soil moisture and the irrigation water demand.

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The impact of point sources of pollution on the transport of micropollutants along the river continuum

Magdalena Urbaniak, Edyta Kiedrzyńska and Maciej Zalewski

International Institute of the Polish Academy of Sciences, European Regional Centre for Ecohydrology under the auspices of UNESCO, Tylna 3, 90-364 Łodź, Poland;
Department of Applied Ecology, University of Lodz, Banacha 12/16, 90-237 Lodz, Poland;
e-mail address: m.urbaniak@unesco.lodz.pl

Human activities in the catchment have direct effects on the rates of contamination in river ecosystems. One of the major threats to surface water quality are point sources of contamination derived directly or indirectly from human activities and/or industrial practices.

The main objectives of this study were twofold: 1) to quantify the transfer of PCDD, PCDF and PCB along the Pilica River continuum and 2) to evaluate the impact of the sewage treatment plants (STPs) located in its catchment on the river quality. In particular the concentrations and toxicity (measured as TEQ concentrations) of PCDD, PCDF and PCB in river and at the outlets from the STPs were tested in the periods of high and low water levels.

The riverine samples were collected twice during the spring (high water level) and summer period (low water level) of 2010. The samples were taken from 5 stations located along the lowland Pilica River, including 2 stations situated above and below the Sulejów Reservoir. In the same time the samples from the outlets from 17 STPs (divided into three size categories: I class: 0 – 1999; II class: 2000 – 9999, IV class: 15000 – 99999 of population equivalent) were collected. PCDD, PCDF and PCB extractions, clean-up and analysis were performed according to US EPA 1613 and 1668 Methods. Identification and quantification were performed using HRGC/HRMS (HP6890, Hewlett Packard/Autospec Ultima, Micromass) with an isotope dilution method.

The results from STPs, show the higher impact of the largest STPs (IV class) which have discharged up to 59.09 μg TEQ of PCDD, PCDF and PCB per day during high flow events and up to 26.03 μg TEQ during low water flows. During the same times the smallest STPs (I class) have released average 0.81 and 0.70 μg TEQ of PCDD, PCDF and PCB per day, respectively. Similarly, the higher TEQ concentrations were noted during the high water flow (average 4.34 pg TEQ L^{-1}) comparing to samples collected during relatively stable hydrological conditions occurring at low flow (average 3.54 pg TEQ L^{-1}). This may indicate problem with maintaining the proper treatment parameters during intensive rain events which in consequence reduce the water quality of receiving Pilica River.

The achieved results also demonstrate the increase in the TEQ concentration of PCDD, PCDF and PCB along the Pilica River continuum (from 4.75 to 6.25 pg TEQ L^{-1}). The exception were samples taken below the dam reservoir wherein the 63% reduction of PCDD, PCDF and PCB TEQ concentration was observed compared to samples collected above the reservoir. This may be the result of deposition and burial of analyzed micropollutants in reservoirs' sediments and biota.

To conclude the concentrations and transfer of analyzed pollutants along the river continuum are accelerated by widespread point sources of pollution which continuously derived PCDD, PCDF and PCB to the river ecosystems.

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Impact of small hydropower plant on biotic environment

S. Vaikasas[1], V. Pliuraite[2] and N. Bastiene[1]

[1]Water Research Institute of the Aleksandras Stulginskis University, Parko str. 6, Vilainiai, LT-58102 Kedainiai, Lithuania, e-mail: s.vaikasas@delfi.lt
[2]Institute of Ecology of Nature Research Centre, Akademijos str. 2, LT-08412 Vilnius-21, Lithuania, e-mail: virga@ekoi.lt

Segmentation of river channels into dammed and undammed reaches results in the changes in integrity of free-flow conditions and greatly disturbs the hydrological regime, coherent with both transport and retention of suspended sediments ant nutrients. The impact of a small hydropower plant (HPP) on the environment, particularly in downstream reaches was investigated in four Lithuanian rivers and involved 17 dams. The height of the dams and the capacities of their reservoirs ranged from 2.25 to 14.50 m and from 28×10^3 to 15.500×10^3 m^3 respectively. To determine the concentrations of suspended solids (SS), total nitrogen (TN), and total phosphorus (TP), water and ground samples were taken about 50 m from each dam, both upstream (reservoir) and downstream (river). Benthic macroinvertebrates and a range of environmental variables were sampled at 3 study sections of each dam: control point, HPP reservoir and below HPP dam. The impact on biotic environment quality was also estimated by the ecohydraulic parameters - Froude Numbers (Fr) and Hilsenhoff biotic indexes (HBI).

It was established that construction of HPP dams substantially changed natural regimes of SS and spread of invertebrates and also had negative influence on the abundance and taxonomic composition of macrozoobenthos. All the reservoirs had been trapped most SS including the finest one. As a result, the percentage of the particles with diameters <0.01 mm in the reservoir bed substrates increased about threefold in proportion to that in the river bed ones. The direct correlation with the coefficients ranging from 0.35 to 0.94 was established between the reservoir capacities and the deposited amounts of these particles. Flood water delay in the reservoir determined reduced concentrations of SS. The TN and TP concentrations decreased by about 11–13% only when the water was delayed in the pond cascades. In pounded reaches above HPP dams, habitats of low Fr number (0.04>Fr>0.0007) were created and negative impact of the dam was observed. The data obtained shows that investigated sections differ in terms of composition and relative abundance of different taxa of macroinvertebrates. Compared to reference conditions (site no influenced by dam), macroinvertebrate samples from the sites below dams had relatively more pollution tolerant Chironomidae larvae and Mollusca, and fewer more pollution sensitive taxa EPT Plecoptera, Ephemeroptera and Trichoptera. HBI index below HPP dam sites was finding worse in comparison with natural (control) sites investigated.

Sediment deposition in the floodplain areas of the Nemunas watershed and its influence on the sedimentation in the Curonian Lagoon

Saulius Vaikasas and Alfonsas Rimkus

Water Research Institute of Aleksandras Stulginskis University, Parko str. 6, Vilainiai, LT-58102 Kedainiai, Lithuania, e-mail: s.vaikasas@delfi.lt

The sedimentation processes in the Nemunas delta, the Curonian Lagoon and the river watershed based on comprehensive data of some researchers were analysed. High rates of river sediments indicate the sediment deposition intensification process in the Lagoon. It was established that about 80000…2480000 t of sand sediment deposited every year in the Lagoon depending on flood probability extent in the Nemunas river. Only 7-11% of this amount was transported into the Baltic Sea. Therefore, the mouth of the Nemunas River is the greatest source of pollutants with nutrient salts leached from agriculture. In the cases of large sediment transport the pollution of the Curonian Lagoon is quite perceptible. As the modeling of the flood activities covering the period of 1950–1991 had been done (based on the "Delta Mathematical model" elaborated by us), it was established that in the grassland area of flooded delta about 80% suspended flood sediments deposited in whole area of the delta. Consequently the flooded areas are very effective for river water self-purification; therefore the separation of large flood plain areas for agricultural or other needs could increase the water pollution of the Lagoon several times. It is possible to reduce the river's organic sediments (wash load) on the Lagoon by means of new sediment and nutrient trap in the flooding Nemunas delta and the watershed. The sediment deposition in the Nemunas delta can be increased by widening inflow in the floodplain area.

The useful effect of self-purification of watercourses and positive impact of natural floodplains on sediment retention and water quality has been investigated in the watershed of the River Nemunas. Due to the erosion of the soil surface about 4830000 t of ground particles was lost each year in the Lithuanian territory of the Nemunas watershed. Some of the amount is deposited on the soil surfaces gullies and sinks. Less than 5 % is mixed with sediments of river-beds and transported like small-suspended sediments along the river bed. Amounts of suspended sediments transported and deposited in the valley and floodplains of Lithuanian part of the Nemunas watershed was calculated. It was established that about 15-23 % of this amount can be deposited on the bottom and slopes of drainage channels and rivulets. Approximately 10-17 % is retained in the pond of Kaunas Hydropower Station, and about 15-24 % is deposited in the inundated floodplains of the Nemunas Delta and wetland areas of its main tributaries. Thus, about 100,000–2,150,000 t or 3-38 % are carried out and can be deposited in the Curonian estuary area/year. Some hydraulic sediment retention measures and pollution reduction possibilities are discussed.

Impact of variable climate conditions on nutrient flux and erosion – five years´ on-line measurements in a small agricultural river

Pasi Valkama[1,2], Kirsti Lahti[1] and Asko Särkelä[1]

[1]The Water Protection Association of the River Vantaa and Helsinki Region, Asemapäällikönkatu 12 B, 00520 Helsinki, Finland, e-mail: firstname.lastname@vesiensuojelu.fi
[2]Department of Geosciences and Geography, University of Helsinki, P.O. Box 64, FI-00014 University of Helsinki, Finland, e-mail:firstname.lastname@helsinki.fi

Dynamic hydrological events cause great variation on water quality as well as sediment and nutrient fluxes in rivers and streams. Majority of diffuse loading from the catchments occur outside the growing season during snowmelt period in spring and in rainy autumn season. Climate models predict that in the near future winters in Finland become milder with higher precipitation as rainfall. Summer temperatures will increase causing drought. Changes in hydrological conditions challenge the mitigation tools used for agricultural loading.

The main objective of this study was to demonstrate the variation in water quality and quantity caused by altering hydrological conditions in a small clayey agricultural catchment in southern Finland using in situ sensors measuring water quality at one hour interval. The results of a five years´ period are presented. This long term, nearly continuous, on-line measurement data is exceptional in Finland.

Water quality and flow rate results consist of over 50 000 hours measuring data from years 2005-2011. Every hour several parameters were measured using YSI (YSI Inc.) and Scan Spectrolyser sensors. Sensor based turbidity correlated significantly with suspended solids, SS (R^2= 0,97, n=122) and total phosphorus, TP (R^2= 0,93, n=122) concentrations analyzed from manual water samples in the laboratory.

The peak of TP concentration was mainly observed on the rising limb of the hydrograph and the peak of NO_3-N concentration in the falling limb. This was suggested to be due to different flow paths of these nutrients.

Fluctuation of water quality and quantity led to notable short term variation in nutrient fluxes and erosion. Considerable variation was also detected between individual seasons and years. Concurrent high TP (>1000 µg/l) and SS (> 800 mg/l) concentrations together with high flow rates were detected in mild winter season (December-March) 2007-2008, leading to high TP ad SS fluxes. Compared to equal period in winter 2009-2010 TP load was over 13 times higher.

In spring 2011 high NO_3-N concentration (> 10 mg/l) coincided with high flow rate caused by the melting of thick snow cover. High concentration resulted from the lack of ground frost and low runoff in preceding autumn. After dry growing season in 2011, NO_3-N concentrations rose considerably during intensive rainfall in September, October and even as late as in December.

High resolution on-line monitoring proved to be a very valuable tool in detection of short and long term variation in water quality and in quantification of nutrient load and erosion. Measuring data is also most useful for the assessment of mitigation measures of diffuse pollution in the future. Long term continuous monitoring has proved its value in predicting erosion and nutrient budgets in the future climate conditions.

Modelling of the nitrogen leaching from drained peat soils on the watershed scale

Anatoli Vassiljev[1]

[1]Tallinn University of Technology, Ehitajate tee 5, Tallinn, 19086, Estonia, e-mail: Anatoli.Vassiljev@ttu.ee

The eutrophication, caused by enlarged loads of nutrients (nitrogen and phosphorus) from watersheds, still remains one of the most important problems for surface waters in Estonia. In many rivers, the concentrations of nutrients exceed the upper hydrochemical limit values of good status established in Estonia (3 mg/l for total nitrogen). Measurements show that very much of nitrogen comes from drained peat soils. Therefore, there is a need to understand and predict the influence of drained peat soils on nitrogen export from catchments. Modeling is a cost-effective means of determining the impact of management alternatives on river water quality. Usually, the modeling of nitrogen leaching includes modeling of water fluxes (because water is a carrier of nitrogen) and modeling of the nitrogen fate.

Most conceptual hydrological models cannot provide the data needed to calculate the nitrogen transformations in soils, and it is difficult to couple them with the existing nitrogen-leaching models. Furthermore, some researchers show that the mobile-immobile water concept, or a division of the soil pore space into a slow and a fast flowing regions can improve the results of nitrogen modeling. Hydrological models developed for watersheds usually ignore the non-equilibrium water movement. The MACRO model for water and solute transport (developed in Sweden) takes into account the non-equilibrium fluxes of water in soils with macropores. This model has been elaborated for use on the field scale and it is coupled with other well-known field scale model SOILN, which simulates nitrogen turnover and leaching.

The objective of this study was to use MACRO and SOILN models on the watershed scale. The differences between the small homogeneous fields and the heterogeneous watersheds are very significant. 1.The zone of aeration is usually thin in areas located close to permanent streams, and quite thick in areas located far from streams and especially on hills. The soil profile with a thin zone of aeration will be saturated very quickly, and will start producing the surface runoff. On the other hand, the soil profile with a thick zone of aeration needs much more water for saturation and very rarely produces surface runoff. 2.The discharge at the watershed outlet depends on its river system. The larger the watershed, the more time is needed for water to reach the outlet. This leads to differences in the time lags between water flows to the outlet of a small field and to the outlet of the whole watershed. Moreover, the river system usually acts as a chain of reservoirs that smooth variations in water flow and quality. The method is proposed, which allows the description of the processes in the river system.

Other task was to use the model for simulation of water flow and quality for the watershed covered mostly by drained peat soils. Results showed that the model gives acceptable results.

Effects of hydropeaking on young Atlantic salmon and competition between young Atlantic salmon and brown trout under hydropeaking flows

T.Vehanen[1], A. Huusko[2], O. Berg[3], M. Puffer[3] and A. Mäki-Petäys[1]

[1]Finnish Game and Fisheries Research Institute, Oulu, Rakentajantie 2, PL 413, 90014 Oulun yliopisto, Finland , e-mail: teppo.vehanen@rktl.fi, aki.maki-petays@rktl.fi
[2]Riista- ja kalatalouden tutkimuslaitos, Kainuu, Manamansalontie 90, 88300 Paltamo, Finland, e-mail: ari.huusko@rktl.fi
[3] University of Science and Technology (NTNU), Høgskoleringen 5, Realfagbygget, 7492 Trondheim, Norway, e-mail: Ole.Berg@bio.ntnu.no, Michael.Puffer@bio.ntnu.no

Physical disturbances, like rapid unpredictable changes in flow, may wash out individual fish or affect habitat use, behaviour and growth. However, the effect of unpredictable peak flows, hydropeaking, on fish communities is poorly known. To study the effect of peaking flows on Atlantic salmon (*Salmo salar*) juveniles we carried out a series of experiments in semi-natural streams in Finnish Game and Fisheries institute, Paltamo Research Unit. The aims for the study were to find out a) if peaking flow affects the growth and movements of Atlantic salmon juveniles and b) does competition with brown trout (*Salmo trutta*) increase the effect of peaking flow on the growth of salmon.

The experiments were conducted in six parallel semi-natural stream channels, each having 26 m long and 1.5 m wide experimental arena. In all six channels stream bed consisted of a 10–15 cm layer of coarse gravel/pebble (20–35 mm in diameter), and they shared the same water source drained from the nearby lake. For the experiment three of the channels were kept under stable water flow conditions (discharge 35 l s^{-1}) and served as the control situation. The other three channels experienced hydropeaking on a diurnal basis, with high water levels during day time for 9 hours (0700 – 1600 hours; UTC +2), and low water levels during the other 15 hours. During the high flow discharge was 65 l s-1, and during the low flow 18 l s^{-1}. To this end, the same amount of water (3060 m^3) flowed through each of the channels during 24 hours. A week before releasing fish to the experimental arenas fishes were tagged with an individually coded passive integrated transponder (PIT) tags. Salmon movements in the channels during the experimental periods were monitored with stationary, swim-through gate antennas using a Texas Instruments Radio Frequency Identification Series 2000 system

Two study periods were run for the growth experiment: winter (from 10 January to 22 March, 2011) and summer (from 16 May to 31 July, 2011). At the start of the seasonal experimental periods, 30 young-of-year Atlantic salmon (density 0.77 fish m^{-2}) were introduced in each of the channels. For the competition study (29 August and ending 6 October 2011) each channel was divided with wire mesh panels into three 8.5 m long sections, with three gravel deflectors in each. Hence, we had nine similar sections located in the control channels and nine in hydropeaking channels. The experimental design included three treatments (3 replicates for each): 10 young-of-year Atlantic salmon (density 0.78 fish m^{-2}), 20 young-of-year Atlantic salmon (density 1.56 fish m^{-2}), and 10 young-of-year Atlantic salmon together with 10 young-of-year brown trout (total density 1.56 fish m^{-2}).

The results show that peaking flow had a substantial effect on the amount and timing of movements by Atlantic salmon juveniles. Due to excessive amount of natural invertebrate food supply salmon juveniles were growing at or close to their capacity, and growth effects of peaking flow remained less significant. The competitive effect from brown trout juveniles on salmon juveniles was, however, evident and should be considered when effects of peaking flows are measured. Here we further discuss the reasons and possible causes of our findings.

Mathematical estimation of shallow groundwater fluctuations under different aquifer characteristics

Artūrs Veinbergs, Didzis Lauva, Valdis Vircavs, Kaspars Abramenko, Zane Dimanta, Ilva Vītola and Agnese Gailuma

Department of Environmental Engineering and Water Management, Latvia University of Agriculture, 19 Akademijas Str. Jelgava, LV-3001, Latvia
e-mail: aarts@inbox.lv

Shallow groundwater (S-GW) is a significant natural resource of Latvia. From human point of view the long term S-GW regime can be described positively as well as negatively. Aspects influencing our assessment are:

- chances to cultivate the agricultural land, water resources for the plants, nutrient leaching processes;
- water regime in area of natural biotopes;
- usable amount of drinking water etc.

According to such aspects it is necessary to investigate the characteristics of S-GW fluctuations – the S-GW aquifer depth, the season when the water reaches the maximal or minimal level and the duration of the same water level. Climatic conditions, geological structure and artificial drainage systems affect characteristics of S-GW flow and vertical groundwater level fluctuations. In Latvia S-GW fluctuations has a seasonal type (Odiņš, 1957).

The objective of this study is to mathematically evaluate spatial dimensions of the aquifer. The mathematical model METUL (Krams, Ziverts, 1993) for groundwater level modelling was applied. Model was created in Latvia and developed to use available daily meteorological data sets. Calculations are based on meteorological data: air temperature, vapour pressure deficit and precipitation. Calibration mainly is based on S-GW observations.

The observation data from two different river basins were applied: agricultural run-off monitoring station Mellupite (Venta river basin) with 3 wells and meteorological data from city Saldus – data set from July 2006 till end of 2010; Zoseni parish (Gauja river basin) with 31 wells and meteorological data from meteorological station in Zosēni parish – data set from 1976.-1984.

Our results show that S-GW level and the fluctuations basically depend on depth (from ground surface) of piezometric pressure level against groundwater aquifer bottom (PZ) as well as pipe drain effective depth (DZ). Average and deepest water level correlates with PZ ($R^2>0.77$), but the highest water level correlates with DZ ($R^2>0.9$). PZ and DZ impact is evaluated as statistically significant with the assurance error <5%. However there is recognised yearly uncertainty of S-GW level dependency of PZ and DZ. As it is estimated in Mellupite monitoring station the largest yearly differences (within 50-55 cm) are observed for the deepest water levels, but relatively smaller (within 5-26 cm) for average and highest water levels.

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Agricultural impact on groundwater quality in south west Latvia

Valdis Vircavs, Artūrs Veinbergs, Didzis Lauva, Kaspars Abramenko, Zane Dimanta, Ilva Vītola and Agnese Gailuma

Faculty of Rural Engineering, Latvia University of Agriculture, 19 Akademijas Str. Jelgava, LV-3001, email: valdis.vircavs@llu.lv

The leaching of nitrogen compounds from agricultural areas has become one of the main problems in Europe Union (EU) countries. However, nitrogen inputs from agriculture are worldwide problem according to Water Framework Directive, Nitrate directive and Groundwater directive.

The study presents data of changes in nitrogen compounds in agricultural watersheds. The purpose of this study is to provide assessment of the differences of water quality between shallow groundwater, drainage field and small catchment in two different diffuse source pollution monitoring sites Bērze and Mellupīte in Latvia.

Monitoring sites are located in south west part of Latvia and represent regions with different farming intensity. The study has been carried out in sandy loam and loamy sand till sediments in active agricultural lands. Results are based on long term water quality monitoring measurements in previously stated monitoring sites from 1995 – 2010. Water quality samples are taken monthly from the drainage systems and small catchment in monitoring sites since 1995. Additionally shallow groundwater quality is monitored once per 4 months starting from the year 2006. Assessment of water quality in monitoring sites defines as biogenic elements – nitrogen and phosphorus. The methodology and analyses was applied for three different levels: small catchment, drainage field and groundwater. Parameters analyzed included: Ntot, NO_3-N, NH_4-N, Ptot, PO_4-P, pH. Nitrogen compounds nitrate nitrogen NO_3-N and ammonia nitrogen NH_4-N are most common ions which are considered close to soil surface environment.

A preliminary statistical analysis is accomplished for the distribution of nitrogen compound concentration in soil profile from soil surface to groundwater aquifer.

Nitrate concentrations vary from year to year and are influenced by land use practices. Existing study indicates that the amount of contamination by various nitrate forms alter depending on agricultural activities and groundwater and surface water interaction capability. Average nitrogen concentrations in subsurface drainage water are higher than concentrations in small catchment and groundwater. Results confirm that distribution of nitrogen concentrations decrease with depth from soil surface and preliminary results show that influence on drainage basin and groundwater can be attributed to agricultural activities.

The present work has been funded by the European Social Fund Project "Establishment of interdisciplinary scientists group and modelling system for groundwater research" (Project Nr. 2009/0212/1DP/1.1.1.2.0/09/APIA/VIAA/060).

Estimation of vegetative flow resistance in environmental channels: Experimental investigations with natural vegetation

Kaisa Västilä and Juha Järvelä

Water Engineering, Aalto University School of Engineering, P.O. Box 15300, 00076 Aalto, Finland, e-mail: kaisa.vastila@aalto.fi, juha.jarvela@aalto.fi

Vegetation is a fundamental element of most riparian and floodplain ecosystems and is therefore an essential component for instance in environmentally preferable river engineering and river restoration. In addition to its biological functions, vegetation prevents excessive erosion of the channel banks and can be used to retain suspended sediment and nutrients on floodplains or constructed wetlands. However, vegetation increases the flow resistance of a channel, causing higher water levels. Sites at which environmentally preferable practices are applied require particularly reliable estimation of the vegetative flow resistance due to the strict boundary conditions imposed by the surrounding intensive land use. For instance, the environmentally preferable solutions at the originally natural but heavily modified small brooks and rivers serving for agricultural drainage need to be carefully designed to prevent flooding on the surrounding fields. Flow resistance is commonly quantified with Manning's n, which channel designers typically estimate from reference publications using professional judgement. Because such a subjective approach involves significant uncertainties when applied to channels having complex geometry and diverse vegetation cover, the focus of this presentation is the estimation of the vegetative flow resistance on the basis of objective, physically sound and readily measurable properties of vegetation.

Vegetative flow resistance was investigated in both laboratory and field experiments. The resistance of several common riparian tree species, including Common Osier (*Salix viminalis*), hybrid Crack Willow (*Salix x rubens*), Common Alder (*Alnus glutinosa*) and Silver Birch (*Betula pendula*) was determined in a laboratory flume. The 25 cm tall specimens (twigs cut from mature trees) were tested at flow velocities ranging from 0.2 to 0.8 m/s. Separate flow resistance formulations were derived for each foliated species, revealing that despite of the inherent natural variability within a species, flow resistance could be estimated by adding the resistance predicted for the leaves to that predicted for the stem on the basis of either the dry mass, wet mass or area of the leaves and stem. Flow resistance per leaf dry mass and leaf wet mass appeared to be somewhat species-specific, being approximately two-fold for *Alnus glutinosa* compared to that for *Salix viminalis*.

The field investigations were carried out at the small agricultural Ritobäcken Brook located in Southern Finland. An environmentally preferable solution to decrease flooding of the fields, the channel has a two-stage profile formed by a narrow main channel and an excavated floodplain at mean water level. At high flows, Manning's was 0.03 for the two-stage channel with the newly excavated, unvegetated floodplain. Subsequently, Common Osier (*Salix viminalis*) and mixed pasture grasses (containing mainly Perennial Ryegrass, *Lolium perenne*) were planted on the floodplain while other grassy species gradually established themselves. Due to the vegetation development reflected by the increasing plant dry mass, Manning's n increased to the value of 0.07 within one year and to the value of 0.13 within 1.5 years, raising the water level in the 200 m long reach by 10-15 cm within one year and by 35 cm within 1.5 years. The obtained relationships between Manning's n and plant dry mass are useful in designing similar channels or restoration projects. As a whole, the laboratory and field studies showed that the vegetative flow resistance can be estimated with plant mass as well as leaf and stem area, which are objective and readily measurable or assessable parameters.

Modelling water flow and soil erosion in clayey, subsurface drained agricultural fields with FLUSH model

Lassi Warsta[1], Tuomo Karvonen[2], Harri Koivusalo[1], Maija Paasonen-Kivekäs[3], Antti Taskinen[4] and Pertti Vakkilainen[1]

[1]Aalto University School of Engineering, Department of Civil and Environmental Eng., P.O. Box 15300, FIN-00076 Aalto, Finland, e-mail: lassi.warsta@aalto.fi
[3]Waterhope, Munkkiniemen Puistotie 20 A 6, FIN-00330 Helsinki, Finland, e-mail: tk@waterhope.fi
[3]Sven Hallinin Tutkimussäätiö, Simonkatu 12 A 11, FIN-00100 Helsinki, Finland, e-mail: maija.paasonen@hallin.fi
[4]Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland, e-mail: antti.taskinen@ymparisto.fi

Cultivated fields are among main sources of nutrients and suspended sediment ending in surface waters in Nordic countries. Water movement in the fields is the key factor controlling erosion and transport of nutrients. In Finland field cultivation is the most intensive in southern and western parts of the country where the most common soil type is clay in the fields. To attain an efficient drainage, clayey soils are usually subsurface drained. According to recent studies in Nordic countries, notable amounts of suspended sediment and nutrients are lost via subsurface drains. The sediment and nutrients originate from the tillage layer of the profile and are transported to the subsurface drains via preferential flow in macropores. Clayey soils are prone to cracking in dry conditions which can promote preferential flow and transport. The objective was to model water flow and soil erosion in the field and quantify the resulting sediment loads via surface runoff and drainflow during the growing seasons and following autumns.

A new numerical model called FLUSH is introduced here to simulate 2-D overland flow and erosion and 3-D subsurface flow and transport processes (Warsta 2011). The model supports simulation of preferential flow and transport of sediment in macropores. The soil shrinkage and swelling model increases the macropore system volume in dry conditions and decreases the volume in moist, swollen conditions. One of the most pressing problems was the computational load arising from the fairly complex multidimensional model. This was partly alleviated with several different approaches including: 1) a new pentadiagonal matrix algorithm based solution approach that solves flow and solute transport simultaneously in two pore systems, 2) parallelization of the algorithms with OpenMP and 3) the option to change computational grid resolution automatically.

The model was applied to two clayey agricultural fields, Sjökulla field in Kirkkonummi and Hovi field in Vihti, in Southern Finland. The model successfully described surface runoff and drainflow volumes and the corresponding sediment loads in the two fields. Runoff distribution between surface runoff and drainflow changed in the autumn due to tillage operations and soil swelling. Soil erosivity also increased after autumn tillage. Hydraulic erosion was the primary process leading to high erosion rates in the Sjökulla field while in the Hovi field the lack of overland flow notably decreased total sediment loads. Comparison of the 3-D model results to 1-D and 2-D scenarios indicated that the application of the 3-D model to undulating, clayey, subsurface drained fields was well justified.

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Effect of water purification at artificial agricultural drainage in dairy farming watershed

Tadao Yamamoto[1], Takashi Inoue[2] and Tetuaki Nagasawa[3]

Research Faculty of Agriculture, Hokkaido University, kita-9 Nishi-9 Kita-ku, Sapporo 060-8589, Japan, e-mail: [1]tady@env.agr.hokudai.ac.jp, [2]tino@env.agr.hokudai.ac.jp, [3]ngsw@env.agr.hokudai.ac.jp

We studied on the effects of water quality improvement in drainage channels with small pools in a small catchment area with dairy farming in eastern Hokkaido, Japan. The improvements entailed installing sandbars angled upstream in order to retard flow, which produced pools and a meandering flow. For water quality measurements, water was taken upstream and downstream in the drainage channel, and discharge was observed at V-notch weirs at those points. Pre-improvement field surveys were carried out between April and October 2004; post-improvement field surveys were carried out between September 2005 and November 2009. In addition to this research, vegetation and bottom sediments in the drainage channel were sampled five times in 2008-2009, and the nitrogen content was analyzed. In the five years since this work, various plants, including reeds, have grown thickly in the drainage channel. These improvements increased the flow time to approximately 30 times and achieved greater reduction in nitrogen and phosphorus load during downflow than observed for the previous conventional straight earthen channel. The reduction in total nitrogen (TN) concentration was greater after channel improvement than before. Before channel improvement, both TN and suspended solids (SS) concentrations were reduced, which is attributed to the elimination of nitrogen by SS sedimentation. A reduction in NH_4-N and an increase in NO_3-N concentrations were observed before channel improvement. The reductions in total phosphorus (TP) and PO_4-P concentrations were greater after improvement. The reductions in TP and PO_4-P concentrations are attributed to elimination by SS sedimentation and to absorption by the channel bed, an attribution that was also made for TN. The effect on nitrogen purification was especially remarkable, which can be attributed to absorption and uptake by vegetation and denitrification. In 2008, the nitrogen (NO_3-N) fixation rate by vegetation was estimated at 24%, with 1% remaining in pool bottom sediments and 75% released to the atmosphere by denitrification. This similar tendency was seen in 2009. These results suggest that denitrification is more efficacious for reduction of TN than absorption by vegetation in the present drainage channel. Moreover, the denitrification rate was estimated at 0.31 (g $m^{-1}d^{-1}$) in 2008 and 0.46 (g $m^{-1}d^{-1}$) in 2009. For example the denitrification rates indicated 0.10 – 0.25 (g $m^{-1}d^{-1}$) (A.R.Hill 1979) and 0.64 (g $m^{-1}d^{-1}$) (H.Kawashima and M.Suzuki) in the previous researches. We believe that these values were consistent within previous research.

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The effect of climate change on Glacier No.1 at the source region of the Urumqi River, Tianshan, China

Feifei Yuan[1], Ronny Berndtsson[1] and Linus Zhang[1]

[1]Division of Water Resources Engineering, Lund University, Box 118, SE-221 00, Sweden, e-mail: feifei.yuan@tvrl.lth.se, Ronny.Berndtsson@tvrl.lth.se, Linus.zhang@tvrl.lth.se

Glaciers are very important water resources, which greatly affect industrial water supply and agricultural productivity. Global warming has caused shrinking of most glaciers in the world over last century, especially in recent decades (Dyurgerov and Meier, 2000). Small glacier is highly sensitive to climate change, which is considered to be the indicator of climate change. This study analyses the changing characteristics of Glacier No.1 at the source region of the Urumqi River during last half century, including the glacier area, surface velocity, equilibrium line altitude (ELA), the thickness and the glacier snout retreat. The trend of precipitation, temperature and runoff at the source region are analysed by linear regression and Mann-Kendall methods based on the historical data from 1985 to 2004. The results reveal the response of glacier to climate change.

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Optimizing small- to medium-scale aquifer storage and recovery in coastal aquifers for irrigation water supply

K.G. Zuurbier[1] and P.J. Stuyfzand[1,2]

[1]KWR Watercycle Research Institute; P.O. Box 1072, 3430 BB Nieuwegein, The Netherlands, e-mail: koen.zuurbier@kwrwater.nl
[2]Faculty of Earth and Life Sciences, Section Geo-environmental Science and Hydrology, VU University Amsterdam

Small- to medium-scale Aquifer Storage and Recovery (ASR) systems, injecting rainwater or treated waste water into local, brackish to saline aquifers, are proposed to maintain a robust and sustainable fresh irrigation water supply in a large Dutch coastal greenhouse area. An important drawback of ASR systems in delta areas is the possible intrusion of brackish groundwater into the wells during the recovery stage, due to lateral groundwater flow and buoyancy effects. Therefore, recent ASR performance estimation methods were applied, using regional hydrogeological and hydrochemical data, to select potentially interesting pilot locations for a field experiment.

In an area where estimated ASR performance was rather limited, yet not impossible, an optimized well configuration using Multiple Partially Penetrating Wells (MPPW) was tested in a field trial. By injecting water at the base of the aquifer and recovering from the top of the aquifer, it was intended to increase freshwater recovery. Detailed aquifer characterization and extensive monitoring of groundwater quality and discharge per well is performed in this ASR field trial. Hereby, the potential increase in the recovery efficiency of optimized ASR systems is explored.

Secondly, water quality changes related to the injection and storage of fresh, oxic rainwater in a brackish, anoxic aquifer are studied, since environmental quality constraints for the recovered irrigation water are strict in the Netherlands.

Effects of the Climate Change on Fluorescence Chlorophyll a in the coastal seas of Kumanonada and Freshwater Dam

Juichi Omote and Yousuke Hatano

Department of Total Systems Engineering and Urban Environment, Kinki University, Technical College, 7-1 Kasugaoka , Nabari-shi, Mie 518-0459, Japan, e-mail: omote@ktc.ac.jp

Global warming and climate change may have even greater repercussions for marine ecosystems than for lake ecosystems, In order to understand the impacts of climate change on the coastal seas and freshwater ecosystems, this paper is investigated and reports on the variation in phytoplankton dynamics in the coastal sea with a lagoon sea and freshwater dam.

The biological scale (as the varing phytoplankton biomass) was determined with using of the fluorescence intensity by the Uranine concentration and measured water quality, water temperature and turbidity as criteria for phytoplankton concentration.

Some important environmental factors controlling the Uranine concentration are water column mixing by wind, wave and tidal action in the coastal shallow seas, not by temperature .These natural phenomen affect the primary mechanism responsible for strong mixing. The vertical and horizontal turbulent transport of sea bottom and pollutants are often of first order significance for understanding property budgets in the coastal seas. On the other hand ecological processes in fresh water lake is more closely related with temperature, even the structure of water body, the seasonal changes etc. depend on temperature. Dam is thermally stratified in summer. Depth profile of summer stratification at the upper 10 m was observed. The temperature influences water column strongly, nutrient enrichment, and changes in the biodiversity of plankton communities and its reproductive cycles. The observation suggest that when increasing the water temperature in the coastal seas ,the fluorescence of Uranine is decreased,. When decreasing the water temperature, the fluorescence of Uranine is increased in the coastal seas. On the other hand the fluorescence intensities dependence on the water temperature were measured clearly for Uranine in the freshwater dam. As we compare fluorescence chlorophyll a concentration in the coastal seas with lagoon waters of Kumanonada , chlorophyll a concentration in the lagoon waters is usually more productive than the coastal region, because nutrient in the lagoon waters may also slightly stabilize water column. The chlorophyll a concentration ranged from 0.15 to 4.5 μg/l in coastal waters, 0.3 to 4.8μg/l in lagoon waters during 26 months from August 2008 to September 2010. The chlorophyll a concentration ranged from 0.33to 3,6 μg/l in the freshwater dam lake during 26 months from August 2008 to September 2010.

Keywords: fluorescence intensity, chlorophyll a, climate change, coastal seas, freshwater lake

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